MONKEY SPRING FLOW MONITORING SYSTEM
INSTALLATION REPORT

Prepared for: Hudbay

Prepared by: WestLand Resources, Inc.

Date: July 2, 2015

Project No.:   1049.59 / 1049.15

TABLE OF CONTENTS

TABLES

FIGURES
(*1-3 follow text*)

ATTACHMENTS

Attachment 1.   12" x 45° SRCRC Trapezoidal Flume Flow Chart
Attachment 2.   FL900 Flow Logger User Manual
Attachment 3.   Ultrasonic Sensor User Manual
Attachment 4.   Trapezoidal Flume Cut Sheet
Attachment 5.   NEMA Enclosure Data Sheet
Attachment 6.   PV Module Data Sheet
Attachment 7.   Solar Controller Data Sheet
Attachment 8.   Site Use Procedures
Attachment 9.   Representative Photographs

WestLand Resources, Inc.
Engineering and Environmental Consultants

1. INTRODUCTION AND BACKGROUND

Hudbay has purchased the Sonoita Creek Ranch property in support of natural resources mitigation for the impacts anticipated from the Rosemont Copper Project. A significant element of the mitigation plans at Sonoita Creek Ranch is the existing constructed irrigation system which utilizes perennial flows from Monkey Spring, which is located on the property immediately north of Sonoita Creek Ranch. The spring flows feed two ponds which act as surge reservoirs for the irrigation of a 115-acre agricultural field on the property. Hudbay contracted WestLand Resources, Inc. (WestLand) to design and install a flow monitoring station within the irrigation canal upstream of the two ponds to ascertain the volume and regularity of flow reporting to the Sonoita Creek Ranch irrigation system.

2. SITE DESCRIPTION

Figure 1 shows the property location in eastern Santa Cruz County between the towns of Sonoita and Patagonia. Sonoita Creek Ranch is located east of State Road (SR) 82, approximately 6 miles south of Sonoita. The flume location is in the irrigation channel on the northeast corner of the property and is shown on the aerial photograph in *Figure 2*. Approximately 2,300 feet south of the flow monitoring station, the irrigation channel terminates and flows discharge into a wetland area on the north end of the northernmost pond.

3. SYSTEM SETUP

In April 2015, WestLand personnel installed a 12" x 45° trapezoidal flume, ultrasonic flow sensor, flow data logger, solar panel, and battery in the Monkey Spring irrigation channel. *Figure 3* shows a detailed depiction of the arrangement of equipment for this installation.

The system was designed so that it could be left unattended for an extended period of time while collecting data. This was accomplished by providing a 20 watt solar panel which powers a 12 volt, deep cycle battery to power the logger. Additionally, the logger has data storage capable of storing 325,000 data points or 1,128 days for 3 channels at 15-minute log intervals. Finally, the trapezoidal style flume was selected for its compatibility with the channel as well as its ability to pass suspended solids and other material which may otherwise impede the flow. For this reason, frequent maintenance is not required for this style of flume.

3.1. EQUIPMENT DETAILS

Table 1 shows the equipment which was purchased and installed.

Table 1. Purchased Equipment

Equipment	Description
Morningstar, SunGuard	Charge controller
SolarTech Power, Inc., J-Series 20W PV Module, SPM020P-BP	Photovoltaic panel
NEMA Enclosures, Wall-Mount Type 4 Enclosure, CHD242412WP	Enclosure for logger and battery
MK Powered, M40-12 SLD M	Rechargeable deep cycle battery
HACH, FL900	Flow data logger
HACH, US9001	Ultrasonic flow sensor
Plasti-Fab, 12" x 45° SRCRC Trapezoidal Flume Assembly, FLUM-1280-1	Channel flume

4. DATA COLLECTION

Once the flume type was inputted, the FL900 data logger directly records the flow in gallons per minute (gpm). Additionally, the data output shows time, water level, temperature, and power supply voltage. A sample of the data which is outputted from the data logger is shown in *Table 2*.

Table 2. Sample Output Data

Time	Lvl (ft)	Flow (gpm)	Temp (°F)	Dst (ft)	Pwr Sply (V)
4/30/2015 12:00	0.006603241	2.432177305	97.25	2.863145828	13.22462082
4/30/2015 13:00	-0.000164986	0	96.35	2.869914055	13.24240494
4/30/2015 14:00	-0.013700803	0	100.4	2.883449872	13.24240494
4/30/2015 15:00	-0.015956879	0	102.65	2.885705948	13.27797318
4/30/2015 16:00	0.451317151	306.5506897	102.2	2.418431918	13.28686523
4/30/2015 17:00	0.529149055	426.5597229	87.35	2.340600014	13.26908112
4/30/2015 18:00	0.534225146	435.2621155	82.4	2.335523923	13.26908112
4/30/2015 19:00	0.526047071	421.2956238	72.95	2.343701998	13.22462082
4/30/2015 20:00	0.531687101	430.8972168	62.15	2.338061968	13.18905258
4/30/2015 21:00	0.532251199	431.8649902	59	2.33749787	13.14459229
4/30/2015 22:00	0.540147146	445.5535889	54.5	2.329601924	13.11791801
4/30/2015 23:00	0.529149055	426.5597229	50.9	2.340600014	13.0556736
5/1/2015 0:00	0.531687101	430.8972168	49.55	2.338061968	13.03788948
5/1/2015 1:00	0.533943176	434.7758179	47.3	2.335805893	13.02899742
5/1/2015 2:00	0.539583047	444.566803	45.95	2.330166022	12.99342918

The FL900 data logger is able to directly log flow based on the specific properties of a 12" x 45° SRCRC Trapezoidal Flume. The flow charts which equate water depth to flow for this flume have been included in *Attachment 1*.

4.1. INITIAL DATA

The initial data collected is displayed in *Figure 4*. It showed a consistent supply of approximately 430 gpm of flow between the hours of 2:00 PM and 9:00 AM daily. It appears the upstream users divert nearly all of the flow from 9:00 AM to 2:00 PM daily. The only variation to this takes place on Sunday where it appears no flow is diverted. There is still a slight decrease in flow during the day on Sunday that is presumably attributed to evaporation. As a rough initial estimate the Sonoita Creek Ranch property sees 430 gpm of flow for 138 hours per week (which equates to 82 percent of the time). This results in an estimate total volume of 3.6 million gallons per week. Future data collection will be used to see if the patterns seen in the initial data collection remain constant over time.

Figure 4. Initial Flow Data
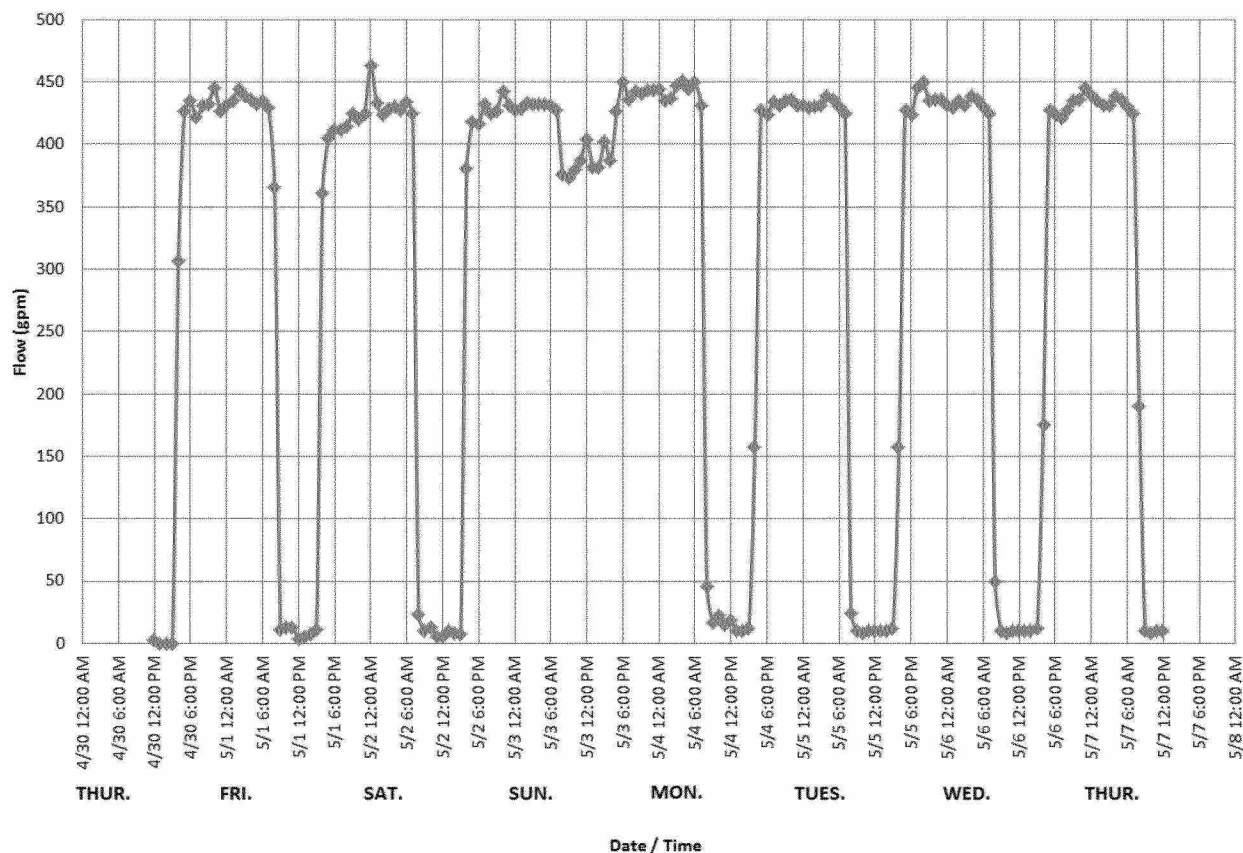
5. MANUALS AND DATA SHEETS

Attachments 2 through 7 include all user manuals, cut sheets, and data sheets provided by the equipment vendors for reference.
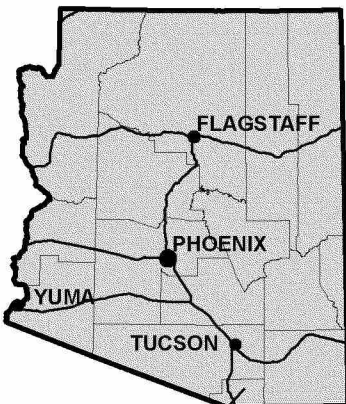
6. SITE USE PROCEDURES

A list of procedures for a typical data collection site visit has been included as *Attachment 8*, along with representative photographs showing onsite equipment in its current operational condition (*Attachment 9*).
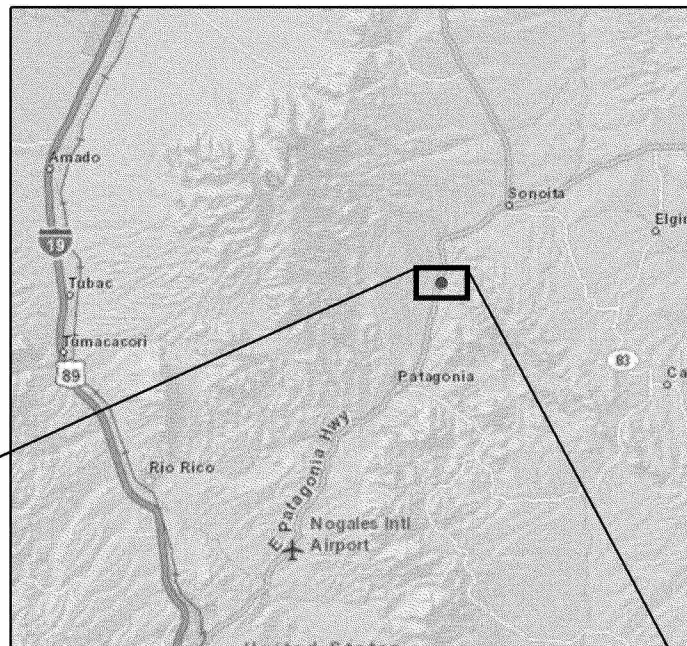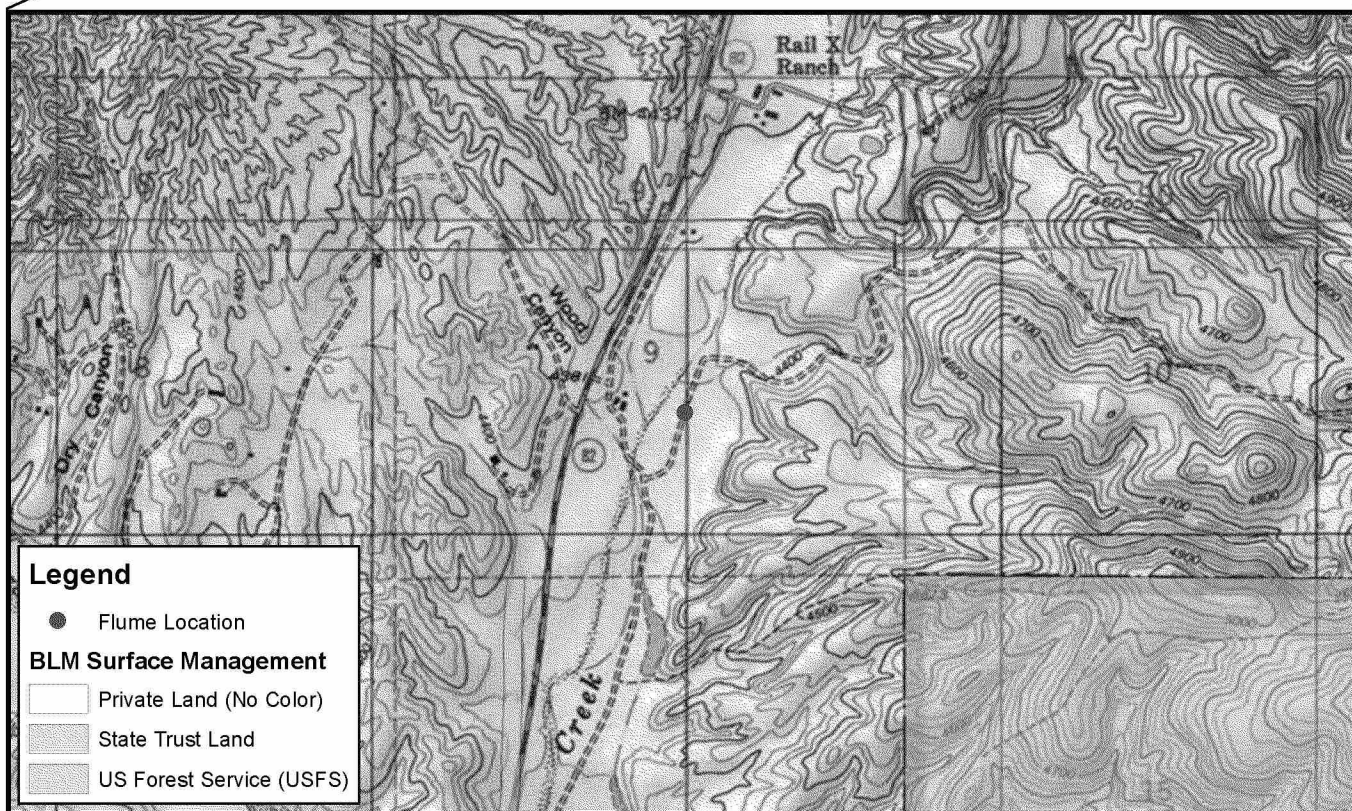
FIGURES

ARIZONA

PORTION OF SANTA CRUZ COUNTY

PROJECT
LOCATION
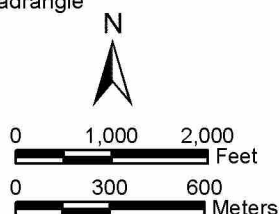
Approximate Scale 1 Inch = 10 Miles

Legend

● Flume Location

BLM Surface Management

☐ Private Land (No Color)

☐ State Trust Land

☐ US Forest Service (USFS)

T21S, R16E, Portion of Sections 9,
Santa Cruz County, Arizona,
Mount Hughes USGS 7.5' Quadrangle

N

WestLand Resources, Inc.
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4001 E. Paradise Falls Drive
Tucson, Arizona 85712   (520) 206-9585

0   1,000   2,000
|___|___|___| Feet

0   300   600
|___|___|___| Meters

HUDBAY
Monkey Spring
Flow Monitoring
Installation Report

VICINITY MAP

Figure 1

ED_002020B_00036104-00006

Arizona Highway 82

Sonoita Creek

LOCATION OF
FLUME INSTALLATION

T21S, R16E, Portion of Sections 9,
Santa Cruz County, Arizona,
Mount Hughes USGS 7.5' Quadrangle
Image Source: National Agriculture Imagery Program June, 2013
Projection: NAD83, UTM Zone 12; Grid Interval: 50 meters

Legend

● Flume Location

HUDBAY
Monkey Spring
Flow Monitoring
Installation Report

AERIAL OVERVIEW LOCATION
Figure 2

WestLand Resources, Inc.
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4001 E. Paradise Falls Drive
Tucson, Arizona 85712   (520) 206-9585

0   100   200
Feet
0   30   60
Meters

N

BARBED WIRE FENCE

FLOW MONITORING
SYSTEM SETUP

EXISTING CHANNEL

TRAPEZOIDAL FLUME

PLAN VIEW

ISOMETRIC VIEW

FIGURE 3
MONKEY SPRING FLOW
MONITORING SYSTEM SETUP

SHEET 1 OF 2   JULY 02, 2015

ATTACHMENT 1

**12" x 45°
SRCRC TRAPEZOIDAL
FLUME FLOW CHART**

Flow Chart for
12" 45° SRCRC Trapezoidal Flume

Head (feet)	MGD	CFS	GPM		Head (feet)	MGD	CFS	GPM
0.16	0.07975	0.12340	55.384		0.56	0.69162	1.0720	481.15
0.17	0.08558	0.13265	59.536		0.57	0.71833	1.1134	499.73
0.18	0.09194	0.14251	63.964		0.58	0.74567	1.1558	518.75
0.19	0.09871	0.15300	68.672		0.59	0.77364	1.1991	538.21
0.20	0.10589	0.16413	73.666		0.60	0.80226	1.2435	558.12
0.21	0.11349	0.17590	78.951		0.61	0.83152	1.2888	578.48
0.22	0.12151	0.18834	84.531		0.62	0.86142	1.3352	599.28
0.23	0.12996	0.20144	90.411		0.63	0.89198	1.3826	620.54
0.24	0.13885	0.21522	96.596		0.64	0.92320	1.4310	642.26
0.25	0.14819	0.22969	103.09		0.65	0.95509	1.4804	664.44
0.26	0.15797	0.24486	109.90		0.66	0.98764	1.5308	687.09
0.27	0.16822	0.26074	117.03		0.67	1.0209	1.5823	710.20
0.28	0.17893	0.27734	124.48		0.68	1.0548	1.6349	733.79
0.29	0.19011	0.29467	132.26		0.69	1.0893	1.6885	757.84
0.30	0.20177	0.31274	140.37		0.70	1.1246	1.7431	782.38
0.31	0.21391	0.33156	148.82		0.71	1.1606	1.7989	807.39
0.32	0.22654	0.35114	157.60		0.72	1.1972	1.8557	832.89
0.33	0.23967	0.37149	166.74		0.73	1.2346	1.9136	858.88
0.34	0.25330	0.39262	176.22		0.74	1.2726	1.9726	885.35
0.35	0.26744	0.41453	186.06		0.75	1.3114	2.0327	912.32
0.36	0.28209	0.43724	196.25		0.76	1.3509	2.0938	939.78
0.37	0.29727	0.46076	206.80		0.77	1.3911	2.1561	967.74
0.38	0.31296	0.48509	217.72		0.78	1.4320	2.2196	996.20
0.39	0.32919	0.51025	229.01		0.79	1.4736	2.2841	1,025.2
0.40	0.34596	0.53623	240.68		0.80	1.5160	2.3498	1,054.6
0.41	0.36326	0.56306	252.72		0.81	1.5591	2.4166	1,084.6
0.42	0.38112	0.59073	265.14		0.82	1.6029	2.4845	1,115.1
0.43	0.39953	0.61927	277.95		0.83	1.6475	2.5536	1,146.1
0.44	0.41850	0.64867	291.14		0.84	1.6928	2.6238	1,177.7
0.45	0.43803	0.67894	304.73		0.85	1.7389	2.6952	1,209.7
0.46	0.45813	0.71010	318.72		0.86	1.7857	2.7678	1,242.3
0.47	0.47881	0.74215	333.10		0.87	1.8333	2.8416	1,275.4
0.48	0.50006	0.77510	347.89		0.88	1.8816	2.9165	1,309.0
0.49	0.52191	0.80896	363.08		0.89	1.9307	2.9926	1,343.2
0.50	0.54434	0.84373	378.69		0.90	1.9806	3.0699	1,377.9
0.51	0.56737	0.87942	394.71		0.91	2.0313	3.1485	1,413.1
0.52	0.59100	0.91605	411.15		0.92	2.0827	3.2282	1,448.9
0.53	0.61523	0.95361	428.01		0.93	2.1349	3.3091	1,485.2
0.54	0.64008	0.99212	445.30		0.94	2.1879	3.3912	1,522.1
0.55	0.66554	1.0316	463.01		0.95	2.2417	3.4746	1,559.5

Flow Chart for
12" 45° SRCRC Trapezoidal Flume

0.96	2.2963	3.5592	1,597.5
0.97	2.3516	3.6450	1,636.0
0.98	2.4078	3.7321	1,675.1
0.99	2.4648	3.8204	1,714.7
1.00	2.5226	3.9100	1,754.9
1.01	2.5812	4.0008	1,795.7
1.02	2.6406	4.0929	1,837.0
1.03	2.7008	4.1863	1,878.9
1.04	2.7619	4.2809	1,921.4
1.05	2.8238	4.3769	1,964.5
1.06	2.8865	4.4741	2,008.1
1.07	2.9500	4.5726	2,052.3
1.08	3.0144	4.6724	2,097.1
1.09	3.0797	4.7735	2,142.5
1.10	3.1457	4.8759	2,188.4
1.11	3.2127	4.9796	2,235.0
1.12	3.2804	5.0847	2,282.2
1.13	3.3491	5.1910	2,329.9
1.14	3.4186	5.2988	2,378.2
1.15	3.4889	5.4078	2,427.2
1.16	3.5601	5.5182	2,476.7
1.17	3.6322	5.6299	2,526.9
1.18	3.7052	5.7430	2,577.6
1.19	3.7790	5.8575	2,629.0
1.20	3.8537	5.9733	2,681.0
1.21	3.9293	6.0905	2,733.6

ATTACHMENT 2

FLOW LOGGER
USER MANUAL

FL900 Series Flow Logger

11/2014, Edition 7

User Manual

ED_002020B_00036104-00015

Table of Contents

Specifications

Specifications are subject to change without notice.

Specification	Details
Dimensions (W x D x H)	25.4 x 22 x 40 cm (10.0 x 8.7 x 16.0 in.)
Enclosure	PC/ABS structural foam
Environmental rating	NEMA 6P/IP68 (24 hours at 1.8 m (6 ft) submersion)
Weight (model FL900)	4.5 kg (10 lb) with no batteries, 6.3 kg (14 lb) with 2 batteries and 8.2 kg (18 lb) with 4 batteries
Operating temperature	–18 to 60 °C (0 to 140 °F) at 95% RH
Storage temperature	–40 to 60 °C (–40 to 140 °F)
Power requirements	8 to 18 VDC from batteries or external power source, 2.5 W max
Battery life	Varies with sensor type, logging intervals, telemetry and environment. For a 15 minute logging interval, with no modem, four 6 V lantern batteries at room temperature: • Flo-tote 3 sensor 306 days • Area Velocity sensor with AV9000 Analyzer 296 days • Flo-Dar sensor 185 days • Ultrasonic sensor 456 days **Note:** *For longer deployments use with Long Life Battery, PN 8542900.*
Installation category	I
Protection class	III
Pollution degree	1
Sensor ports	1, 2 or 4 ports
Primary devices	Contains algorithms to support the primary devices that are shown in Table 1.
Connectors	Stainless steel connectors
Datalog channels	16 maximum
Alarms	Maximum of 16 channel alarms with high/high, high, low, low/low options. System alarms include low battery, low RTC battery, low slate memory, slate memory full, sensor time out, sensor ID.
Alarm actions	Start the sampler, change the log interval, change the call interval, send an e-mail or a text message (SMS) from logger or server. **Note:** *SMS rates may apply. Not all alarm types may be available with all cellular carriers and service plans.*
Logging intervals	1, 2, 3, 4, 5, 6, 10, 12, 15, 20, 30 or 60 minutes
	Primary and secondary intervals for dynamic logging
Data storage	Event log: 1000 events maximum in non-volatile flash memory
	Sample history: 2000 sample events maximum in non-volatile flash memory
	Datalog: 325,000 data points; 1128 days for 3 channels at 15-minute log intervals
PC communication	USB
	RS232 (Baud rates: 9600, 19200, 38400, 57600, 115200)

Specification	Details
Remote communication (optional)	Wireless Modem: CDMA 2000, 1xRTT (US Only); 2G, 3G GPRS (US and Canada)
Protocols	Modbus RTU (RS232)
	Mobile-Terminated SMS
	Mobile-Originated SMS
Timebase accuracy	±0.002%, synchronized every 24 hours with server software and modem
Supported sensors	Flo-Dar, Flo-Dar with SVS, Flo-Tote, Rain Gauge, Ultrasonic, Submerged Area Velocity[1], Sigma 950[1]
Sampler interface	Compatible with Sigma 900 Standard, Sigma 900 Max and Hach SD900 to support set point sampling, flow-pacing and sample history logging
Certifications	Logger: CE
	Optional AC power supply: UL/CSA standards (cETLus)/CE
	Modems: FCC, IC, others may be available—contact the manufacturer for more information.
Warranty	1 year

[1] This device attaches through an external module. Refer to External devices on page 30.

Table 1 Primary devices supported

Primary devices	Type	Details
Weir	V-notch	22.5–120 ° notch
	Contracted rectangular	—
	Non-contracted rectangular	—
	Cipolletti	—
	Compound V-notch	22.5–120 ° notch, 0–61 cm (0–24 in.) notch height, contracted and non-contracted
	ThelMar	6, 8, 10, 12 and 15 in.
Nozzles	Kennison	6, 8, 10, 12, 16, 20, 24, 30 or 36 in. diameter, half and not half
	California Pipe	91 cm (36 in.) diameter and less

Table 1 Primary devices supported (continued)

Primary devices	Type	Details
Flumes	Parshall	1, 2, 3, 6, 9, 12, 18, 24, 30, 36, 48, 60, 72, 84, 96, 108, 120, 144, 180, 240, 300, 360, 480 and 600 in. throat width
	Palmer-Bowlus	4, 6, 8, 10, 12, 15, 18, 21, 24, 27, 30, 36, 42, 48, 60 and 72 in. flume
	Leopold-Lagco	4, 6, 8, 10, 12, 15, 18, 20, 21, 24, 27, 30, 36, 42, 48, 54, 60, 66 and 72 in. pipe diameter
	HS	0.4, 0.6, 0.8 and 1.0 ft flume
	H	0.5, 0.75, 1.0, 1.5, 2, 2.5, 3 and 4.5 ft flume
	HL	3 ft and 4 ft flume
	Trapezoidal	12 in. 45 ° SRCRC, 2 in. 45 ° WSC, 8 in. 60 ° V, small 60° V, large 60 ° V and extra large 60 ° V
	Cutthroat	1, 2, 3, 4, 6, 8, 12, 16, 24, 48 and 72 in. throat width, 8, 36, 54 and 108 in. length of rectangular cutthroat
	RBC	50, 75, 100, 150 and 200 mm flume
	Montana	1, 2, 3, 6, 9, 12, 18, 24, 30, 36, 48, 60, 72, 84, 96, 108, 120, 144, 180, 240, 300, 360, 480 and 600 in. throat width
	British Rectangular	1, 2, 3, 6, 9, 12, 18, 24, 30, 36, 48, 60, 72, 84, 96, 108, 120, 144, 180, 240, 300, 360, 480 and 600 in. throat width
	San Dimas	More than 0 in. flume
Manning equations	Circular	More than 0 in. diameter, 0–1.0 slope, 0.0010–0.75 roughness coefficient
	Rectangular	More than 0 in. width, more than 0 in. height of the channel, 0–1.0 slope, 0.0010–0.75 roughness coefficient
	Trapezoidal	More than 0 in. bottom width, more than 0 in. height of the trapezoidal part of the channel, more than 0 in. top width, 0–1.0 slope, 0.0010–0.75 roughness coefficient
	U-shape	More than 0 in. diameter, more than diameter/2 in. channel height, 0–1.0 slope, 0.0010–0.75 roughness coefficient
Area velocity	Circular	—
	Rectangular	—
	Trapezoidal	—
	U-shape	—
	Level area table	60-point table
Tables	Head flow	60-point table

General information

In no event will the manufacturer be liable for direct, indirect, special, incidental or consequential damages resulting from any defect or omission in this manual. The manufacturer reserves the right to make changes in this manual and the products it describes at any time, without notice or obligation. Revised editions are found on the manufacturer's website.

ED_002020B_00036104-00019

Safety information

NOTICE

The manufacturer is not responsible for any damages due to misapplication or misuse of this product including, without limitation, direct, incidental and consequential damages, and disclaims such damages to the full extent permitted under applicable law. The user is solely responsible to identify critical application risks and install appropriate mechanisms to protect processes during a possible equipment malfunction.

Please read this entire manual before unpacking, setting up or operating this equipment. Pay attention to all danger and caution statements. Failure to do so could result in serious injury to the operator or damage to the equipment.

Make sure that the protection provided by this equipment is not impaired. Do not use or install this equipment in any manner other than that specified in this manual.

Use of hazard information

⚠ DANGER

Indicates a potentially or imminently hazardous situation which, if not avoided, will result in death or serious injury.

⚠ WARNING

Indicates a potentially or imminently hazardous situation which, if not avoided, could result in death or serious injury.

⚠ CAUTION

Indicates a potentially hazardous situation that may result in minor or moderate injury.

NOTICE

Indicates a situation which, if not avoided, may cause damage to the instrument. Information that requires special emphasis.

Precautionary labels

Read all labels and tags attached to the instrument. Personal injury or damage to the instrument could occur if not observed. A symbol on the instrument is referenced in the manual with a precautionary statement.

⚠	This is the safety alert symbol. Obey all safety messages that follow this symbol to avoid potential injury. If on the instrument, refer to the instruction manual for operation or safety information.
⚡	This symbol indicates that a risk of electrical shock and/or electrocution exists.
	This symbol indicates the presence of devices sensitive to Electro-static Discharge (ESD) and indicates that care must be taken to prevent damage with the equipment.
	This symbol indicates radio waves.
	Electrical equipment marked with this symbol may not be disposed of in European domestic or public disposal systems. Return old or end-of-life equipment to the manufacturer for disposal at no charge to the user.

ED_002020B_00036104-00020

Confined space precautions

<table>
<tr><td rowspan="2">⚠</td><td>^ D A N G E R</td></tr>
<tr><td>Explosion hazard. Training in pre-entry testing, ventilation, entry procedures, evacuation/rescue procedures and safety work practices is necessary before entering confined spaces.</td></tr>
</table>

The information that follows is supplied to help users understand the dangers and risks that are associated with entry into confined spaces.

On April 15, 1993, OSHA's final ruling on CFR 1910.146, Permit Required Confined Spaces, became law. This standard directly affects more than 250,000 industrial sites in the United States and was created to protect the health and safety of workers in confined spaces.

Definition of a confined space:

A confined space is any location or enclosure that has (or has the immediate potential for) one or more of the following conditions:

- An atmosphere with an oxygen concentration that is less than 19.5% or more than 23.5% and/or a hydrogen sulfide (H_2S) concentration that is more than 10 ppm.
- An atmosphere that can be flammable or explosive due to gases, vapors, mists, dusts or fibers.
- Toxic materials which upon contact or inhalation can cause injury, impairment of health or death.

Confined spaces are not designed for human occupancy. Confined spaces have a restricted entry and contain known or potential hazards. Examples of confined spaces include manholes, stacks, pipes, vats, switch vaults and other similar locations.

Standard safety procedures must always be obeyed before entry into confined spaces and/or locations where hazardous gases, vapors, mists, dusts or fibers can be present. Before entry into a confined space, find and read all procedures that are related to confined space entry.

Certification

Canadian Radio Interference-Causing Equipment Regulation, IECS-003, Class A :

Supporting test records reside with the manufacturer.

This Class A digital apparatus meets all requirements of the Canadian Interference-Causing Equipment Regulations: CAN ICES-3(A)/NMB-3(A).

Cet appareil numérique de classe A répond à toutes les exigences de la réglementation canadienne sur les équipements provoquant des interférences.

FCC Part 15, Class "A" Limits

Supporting test records reside with the manufacturer. The device complies with Part 15 of the FCC Rules. Operation is subject to the following conditions:

1. The equipment may not cause harmful interference.
2. The equipment must accept any interference received, including interference that may cause undesired operation.

Changes or modifications to this equipment not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment. This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference, in which case the user will be required to correct the interference at their expense. The following techniques can be used to reduce interference problems:

1. Disconnect the equipment from its power source to verify that it is or is not the source of the interference.
2. If the equipment is connected to the same outlet as the device experiencing interference, connect the equipment to a different outlet.
3. Move the equipment away from the device receiving the interference.
4. Reposition the receiving antenna for the device receiving the interference.
5. Try combinations of the above.

Wireless modem certification

The device complies with Part 15 of the FCC Rules and Industry Canada license-exempt RSS standard(s). Operation is subject to the following conditions:

1. The equipment may not cause harmful interference.
2. The equipment must accept any interference received, including interference that may cause undesired operation.

Changes or modifications to this wireless communication equipment not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment. Any change to the equipment will void the Industry Canada certification and FCC grant. Changes and modifications include any modifications to the wireless modems and associated antennas, including antenna cables. Follow the manufacturer recommendations for product installation, configuration and wireless operation.

Cellular devices

> **NOTICE**
>
> Network and access point security is the responsibility of the customer that uses the wireless instrument. The manufacturer will not be liable for any indirect, special, incidental or consequential damages caused by a breach in network security.

> **⚠ WARNING**
>
> Pacemaker precautions. If electromagnetic interference (EMI) occurs, it can either:
>
> - Stop the stimulating pulses from the pacemaker that control the rhythm of the heart.
> - Cause the pacemaker to supply the pulses irregularly.
> - Cause the pacemaker to ignore the rhythm of the heart and supply pulses at a set interval.
>
> Current research shows that cellular devices are not a significant health problem for most pacemaker wearers. However, persons with pacemakers should use precautions to make sure that their device does not cause a problem. Keep the device a minimum of 20 cm (7.9 in.) from the user.

> **⚠ CAUTION**
>
> Electromagnetic radiation hazard. Make sure that the antenna is kept at a minimum distance of 20 cm (7.9 in.) from all personnel in normal use. The antenna cannot be co-located or operated in conjunction with any other antenna or transmitters.

> **⚠ CAUTION**
>
> Electromagnetic radiation hazard. In portable applications, do not use the modem within 20 cm (7.9 in.) of the user.

Regulatory RF device approvals

Modem MTSMC-EV3-IP-N3 (Equipment Class: PCS Licensed Transmitter, Dual-Band CDMA/GPS module):

- FCC: Approved as a Modular Device with a TCB Grant of Authorization. FCC ID: RI7DE910-DUAL
- IC: Approved as a Modular Device with Certificat D'Acceptabilite' Technique C-REL ID: 5131A-DE910Dual

Modem MTSMC-H5-IP (PCS Licensed Transmitter, WWAN module):

- FCC: Approved as a Modular Device with a TCB Grant of Authorization. FCC ID: RI7HE910
- IC: Approved as a Modular Device with Certificat D'Acceptabilite' Technique C-REL ID: 5131A-HE910

Table 2 Power for Modem CDMA

FCC rule parts	Frequency range (MHz)	Output (watts)
22H	824.7 to 848.31	0.30
24E	1851.25 to 1908.75	0.274

Cellular Modem MTSMC-EV3-IP-N3 (CDMA)—Important FCC Grant Conditions:

The power shown in Table 2 is RF conducted power. The maximum antenna gain is 5.12 dBi for part 22H and 6.12 dBi for part 24E. The maximum antenna gain includes the cable loss for compliance with radiated power limits, RF exposure requirements and the categorical exclusion requirements of 2.1091. Install the antenna(s) for this transmitter so there is a minimum distance of 20 cm (7.9 in.) from all persons. Install the antenna(s) for this transmitter so that the antenna does not transmit at the same time as other antennas or transmitters. Only use this device for OEM integration into host products. Consumer or end-user installation is not permitted. End-users and OEM integrators must be supplied with the information that is necessary to satisfy RF exposure compliance.

Table 3 Power for Modem GPRS

FCC rule parts	Frequency range (MHz)	Output (watts)	Emission designator
22H	824.2 to 824.2	1.995	300KGXW
22H	824.2 to 848.8	0.997	300KG7W
22H	826.4 to 846.4	0.446	4M20F9W
27	1712.4 to 1752.6	0.226	4M20F9W
24E	1850.2 to 1909.8	0.993	300KGXW
24E	1850.2 to 1909.8	0.380	300KG7W
24E	1852.4 to 1907.6	0.243	4M20F9W

**Cellular Modem MTSMC-H5-IP (GPRS):—Important FCC Grant Conditions:**

The power shown in Table 3 is RF conducted power. The maximum antenna gain is 5.22 dBi for part 22H, 3.31 dBi for part 24E and 6.45 dBi for part 27. The maximum antenna gain includes cable loss for compliance with radiated power limits, RF exposure requirements and the categorical exclusion requirements of 2.1091. Install the antenna(s) for this transmitter so there is minimum distance of 20 cm (7.9 in.) from all persons. Install the antenna(s) for this transmitter so that the antenna does not transmit at the same time as other antennas or transmitters that are not in the description of this FCC ID (identifier), unless in accordance with FCC multi-transmitter product procedures. The final product that operates with this transmitter must include operating instructions and antenna installation instructions for end users and installers to satisfy RF exposure compliance requirements. Compliance of this device in all final product configurations is the responsibility of the grantee. The submission of a Class II permissive change application that includes the data applicable to RF exposure, spurious emissions, ERP/EIRP and host/module authentication or new application may be necessary for installation of this device into final products. This device contains GSM functions that are not operational in the U.S. This filing is only applicable for U.S. operations.

Product overview

The FL900 series flow loggers are used in open-channel flow monitoring studies such as inflow & infiltration (I&I), combined sewer overflow (CSO), capacity and planning and storm water runoff monitoring.

Data is collected from attached sensors and logged for future retrieval. The sensors can be added or changed in the field. Depending on the model, up to four sensors can be connected. The data can be retrieved directly through a USB or RS232 cable or remotely through a wireless network with FSDATA Desktop and FSDATA server software. Refer to Figure 1. The FL900 Series loggers can also connect to an external power source, rain gauge or be used to pace a Sigma sampler.

The wireless option and the number of available connectors varies with the model of the logger. Refer to Figure 2 and Figure 3.

Figure 1 System overview with wireless option
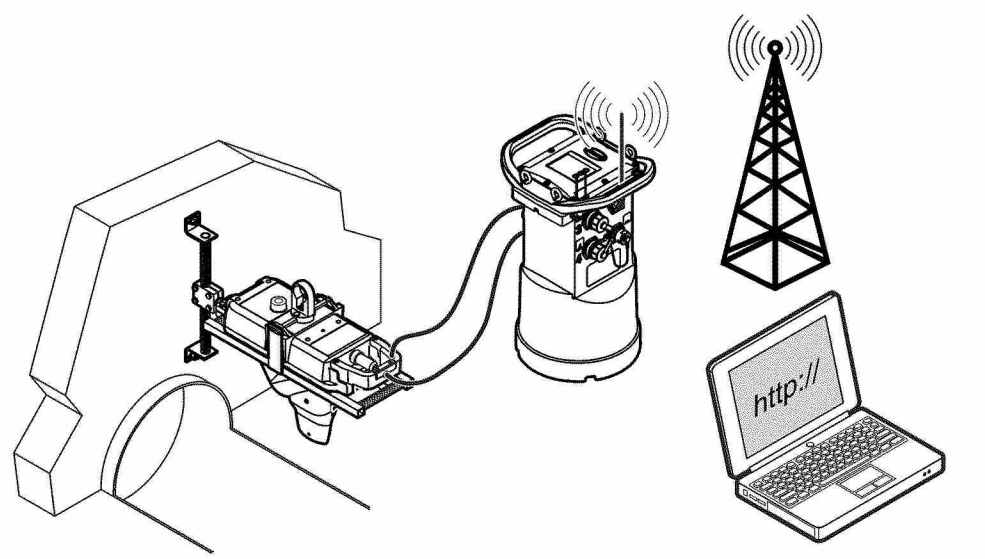
Figure 2 Connectors—side 1
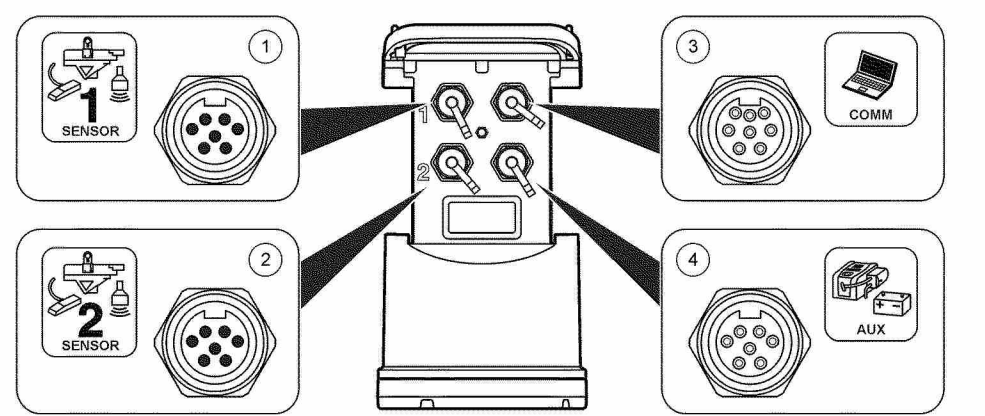
1 Sensor (all models)	3 Computer—USB or RS232 cable (all models)
2 Sensor (FL902, FL904 only)	4 Auxiliary—external power or sampler (all but FL900)

Figure 3 Connectors—side 2
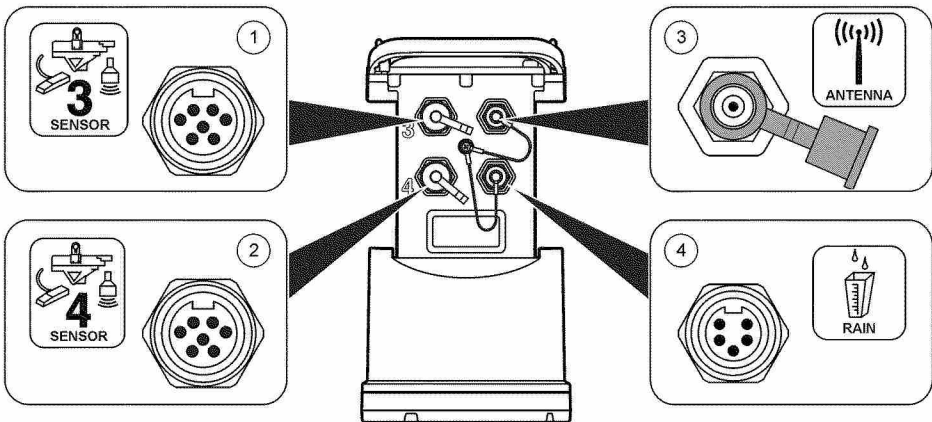
1	Sensor (FL904 only)	3	Antenna option (all but FL900)
2	Sensor (FL904 only)	4	Rain gauge (all but FL900)

Product components

Make sure that all components have been received. Refer to Figure 4. If any items are missing or damaged, contact the manufacturer or a sales representative immediately.

Figure 4 FL900 series logger components
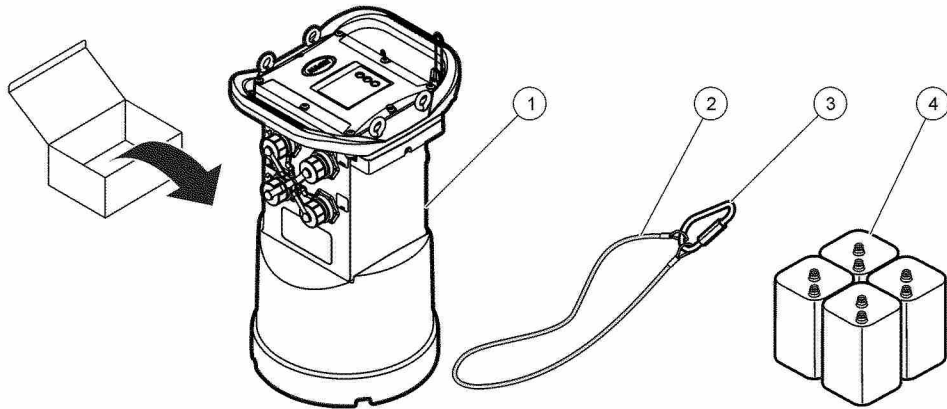
1	Logger	3	D-ring with threaded lock
2	Cable, suspension	4	Batteries, 6 V alkaline (4x)

Apply power to the Logger

Install the batteries

⚠ WARNING
Explosion hazard. Incorrect battery installation can cause the release of explosive gases. Be sure that the batteries are of the same approved chemical type and are inserted in the correct orientation. Do not mix new and used batteries.

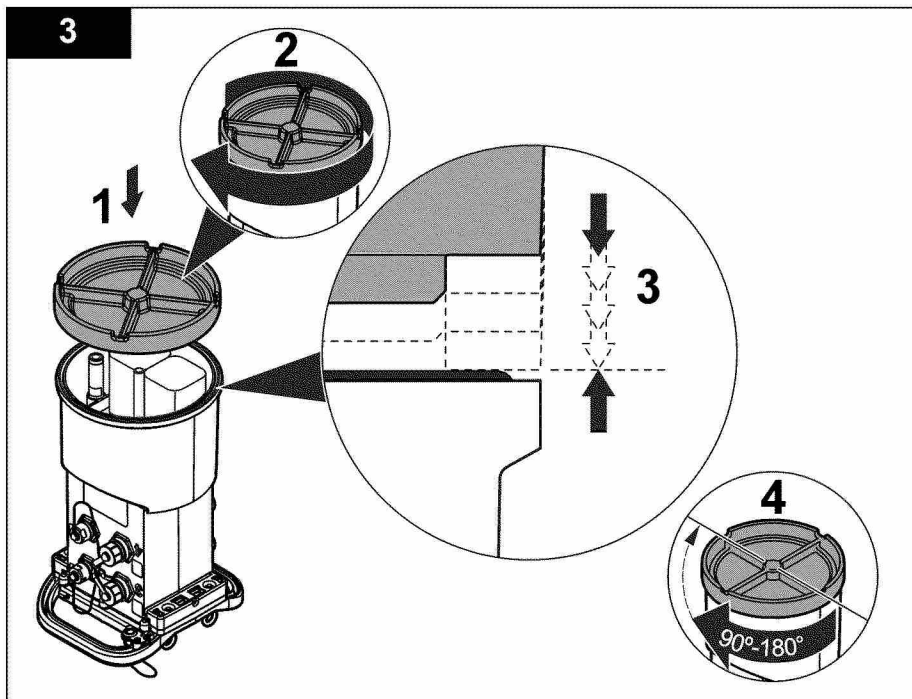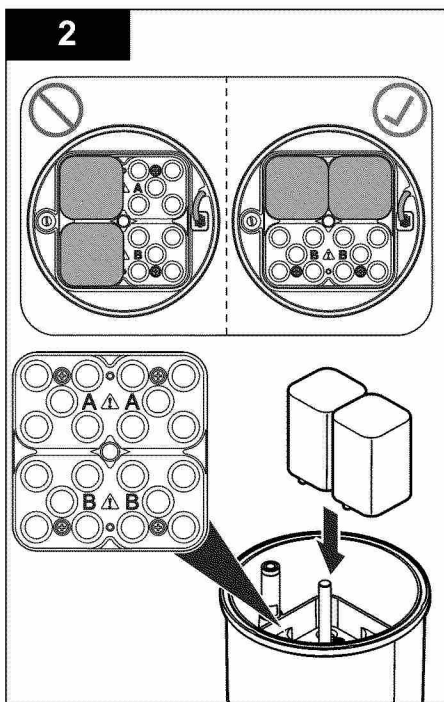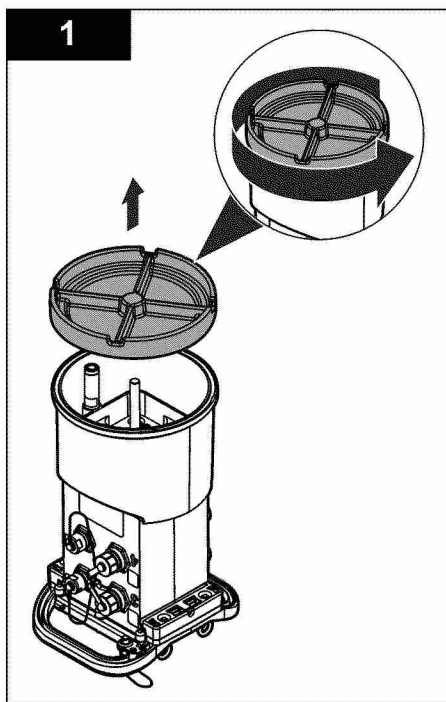| ⚠ WARNING |
| --- |
| Fire hazard. Battery substitution is not permitted. Use only alkaline batteries. |

N O T I C E
Do not over-tighten the cover. Tighten until the cover just touches the O-ring, then tighten one-quarter to one-half turn maximum from O-ring contact. Keep the O-ring lubricated with silicone grease.

The instrument can use two or four 6 V batteries for power. Use two batteries for short-term use or four batteries for long-term use (for battery life, refer to Specifications on page 3). When only two batteries are used, put both batteries on the same side of the compartment (A-A or B-B). Refer to the illustrated steps that follow.

Changes in temperature and pressure can cause the battery compartment cover to be difficult to remove by hand. If this occurs, a tool can be used to remove the cover (Figure 5).

Figure 5 Battery cover removal
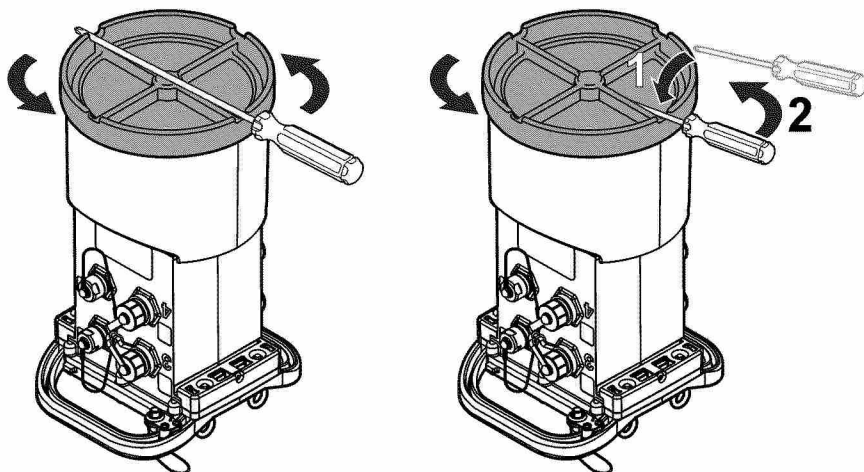
## Attach an external power supply (optional)

> **⚠ WARNING**
>
> Potential explosion hazard. The instrument is not approved for use in hazardous locations.

The instrument can be powered by an external long-life battery, an SD900 power supply or other source that can supply power in the specified range (refer to Specifications on page 3 and Replacement parts and accessories on page 29). If the logger has both external power and internal batteries, the internal batteries are used as an auxiliary power supply. When the external power falls below approximately 9 V, the internal batteries supply power until the voltage from the external source is above 9 V.

1. Install the external power source in a safe location near the logger. Be sure to obey all safety precautions for the power supply.
2. Attach the cable from the power source to the AUX connector on the logger (Figure 6).
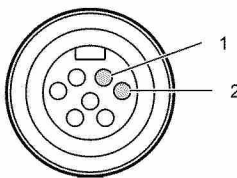3. Apply power to the power source, if applicable.

Figure 6 External power options
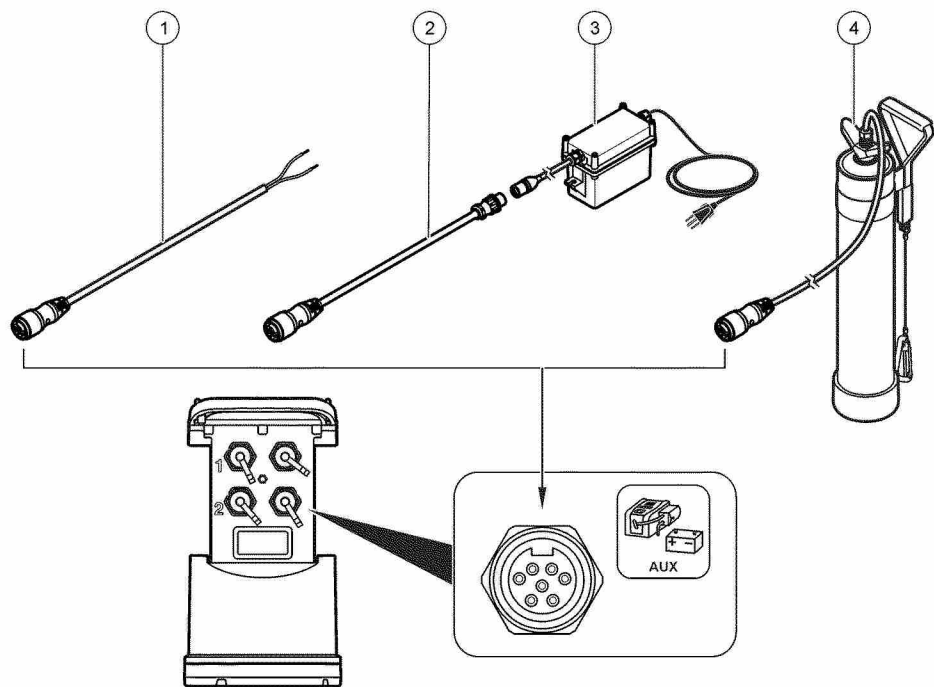
1	2-conductor power cable (Figure 7)	3	SD900 power supply
2	Power adapter cable	4	Long-life battery

Figure 7 2-conductor power cable wiring

| 1 Power—#16 AWG red	2 Common—#16 AWG black

System startup

Install FSDATA Desktop on a computer

Before the FL900 Logger is connected to a computer, make sure that FSDATA Desktop is installed on the computer. FSDATA Desktop is available at www.hachflow.com.

Attach the logger to the computer

Pre-requisites: Make sure that FSDATA Desktop is installed on the computer.
Connect only one logger to the computer.

1. Attach the logger to the computer (Figure 8).
2. When a USB cable is attached for the first time, the Found New Hardware wizard opens. Run the new hardware wizard to install the USB driver for the logger. When finished, the message "Your new hardware is installed and ready to use" is shown. In the event the wizard does not run or the install fails, contact Hach Flow Tech Support to assist with trouble shooting your specific operating system.

Figure 8 Attach the logger to a computer
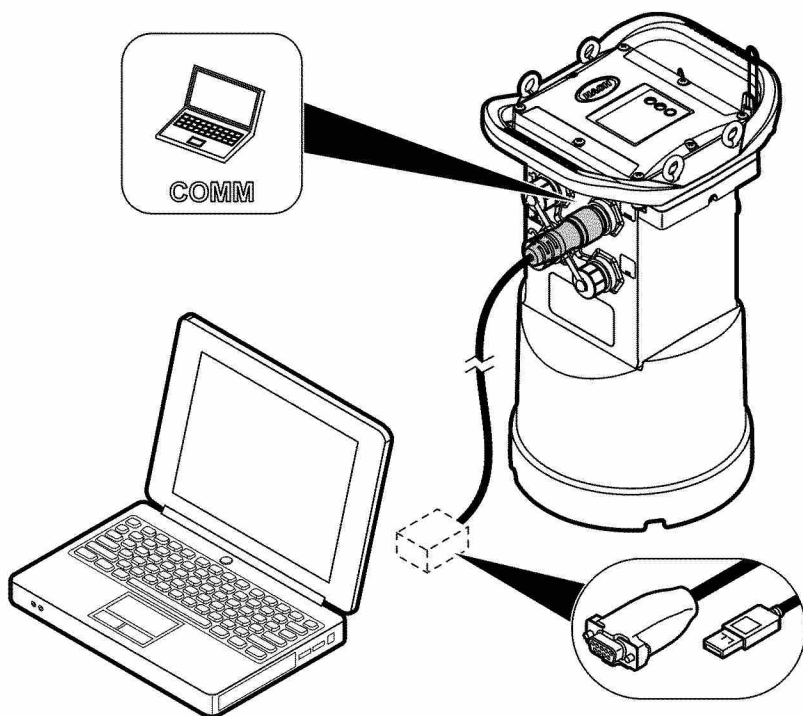
Attach a sensor or external devices to the logger

Pre-requisite: Make sure that the connection status is "not connected".

> ⚠ **WARNING**
>
> Sensor Hazardous Locations and RF Exposure Hazards. Some sensors have RF radiation exposure hazards and are used in explosive atmospheres. See sensor manual warnings and instructions before connecting a sensor to the logger.

The number of sensors that can attach to the logger varies with the model of the logger. Some sensors must attach to an external module that is used as an interface between the sensor and the logger. Figure 10 shows the AV9000 Area Velocity Analyzer module on the side of the logger and the connection to a submerged area/velocity sensor.

1. If the sensor cable has connectors on both ends, attach the cable to the sensor first.
2. Attach the sensor (or module) to any SENSOR port on the logger (Figure 9 or Figure 10). Tighten the connector by hand.

   Note: For rain gauges, attach the sensor to the RAIN connector.
3. If the sensor uses an external module, attach the module to the logger, then attach the sensor to the module (Figure 10).
4. If the sensor cable has a desiccant hub, align the desiccant hub vertically and make sure that the air port points down (Figure 9).

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Figure 9 Attach a sensor to the logger
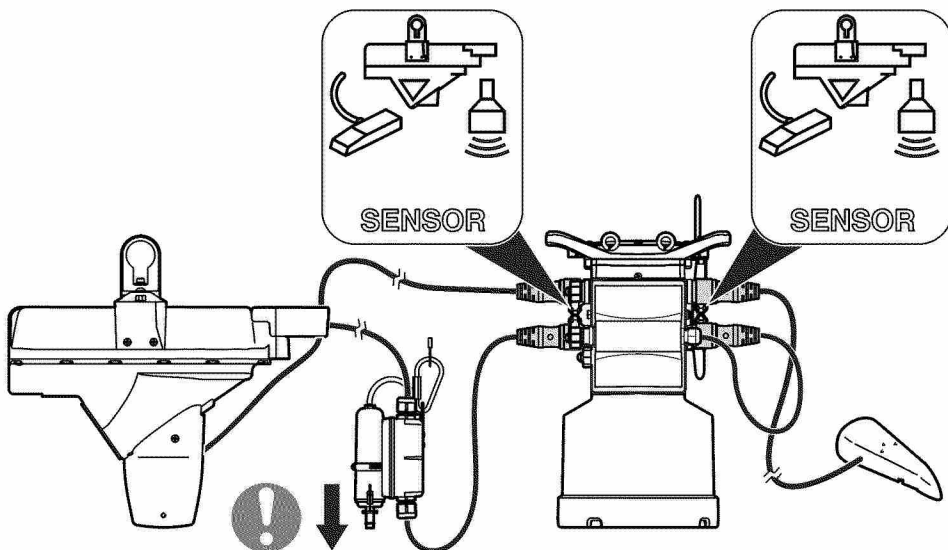
Figure 10 Attach a sensor to an external module
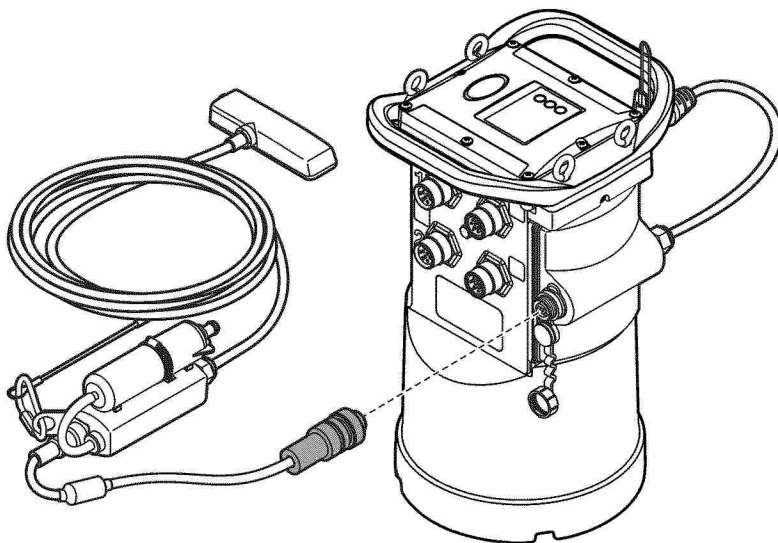
Attach an external module

An external module must be used as an interface between some sensor types and the logger. The external module is mounted on the side of the logger (Figure 10 on page 17). Refer to the documentation that is supplied with the module for mounting instructions.

Attach a sampler

The logger can attach to a Sigma 900 Standard, Sigma 900 Max, Hach SD900 or Hach AS950 sampler for flow-paced and set point sampling. The sampler also supplies power to the logger

and to attached sensors. Connect the auxiliary cable to the AUX port on the logger and to the auxiliary port on the sampler. To make a sampler program, refer to the documentation that is supplied with the sampler.

User interface

The indicators on the user interface show the status of the instrument and the modem. Refer to Figure 11 and Table 4.

Figure 11 User interface
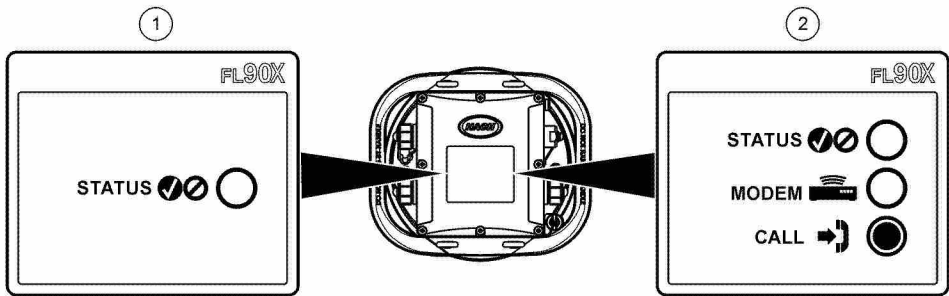
1 Instrument without modem	2 Instrument with modem

Table 4 LED status indicators

Indicator	LED color	Description
STATUS ✔⊘ ◯	Green	Flashes every 3 seconds during normal operation. Flashes every 15 seconds during sleep mode.
	Red	Flashes when an attached sensor does not agree with the logger program, an expected sensor is not found or the sensor operation has failed.
MODEM ▀▀◯	Green	Stays green during a call to the server.
	Red	Flashes red if the call to the server failed.

Program a unit equipped with a modem

> ⚠ **C A U T I O N**
>
> Electromagnetic radiation hazard. Make sure that the antenna is kept at a minimum distance of 20 cm (7.9 in.) from all personnel in normal use. The antenna cannot be co-located or operated in conjunction with any other antenna or transmitters.

For units without a modem, refer to Basic setup on page 25. For units that come with activated modem accounts[*], go to Add the logger to the FSDATA Server on page 22.

Set up the wireless account

Note: Adequate cellular coverage from the selected carrier must be verified for each site before a logger with a cellular modem is purchased.

---

[*] The units that come with activated modem accounts have patent numbers with GX, .GR, .VX, or .VR as the last digits.

When the logger has a modem, data can be sent from the logger to the internet for remote access. The user must first open an account with a mobile (wireless) provider. The instrument is then registered to the data-hosting server (FSDATA), and the applicable communication settings are programmed into the logger with FSDATA Desktop. If the modem was activated at the factory, go to Add the logger to the FSDATA Server on page 22.
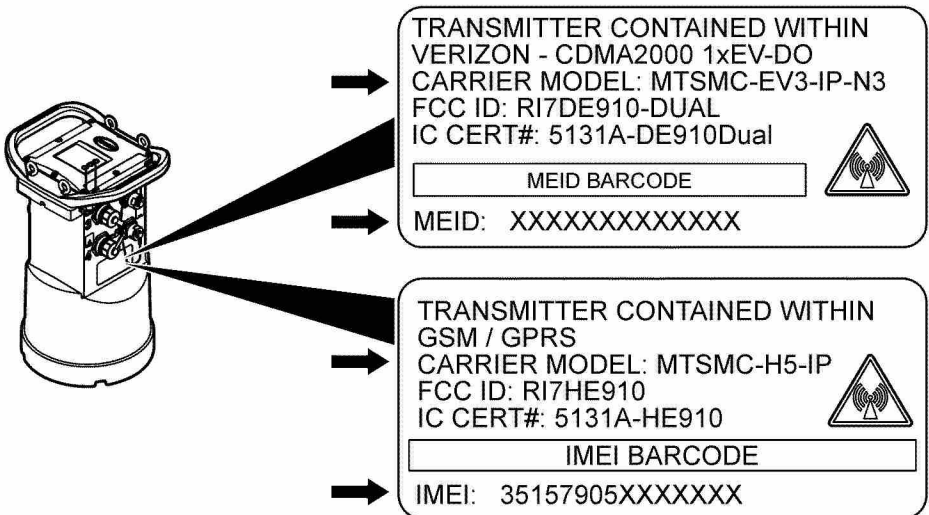
Pre-requisite: Make sure that the logger, logger test certificate and antenna are nearby.

Mobile (wireless) providers use CDMA or GPRS technology for data transmission.

Note: For optimal troubleshooting, install the FSDATA Desktop driver, add the logger to the FSDATA server, and verify telemetry before visiting the deployment site.

1. Gather your account information.

   a. Find the MEID or IMEI number from the label. Refer to Figure 12.
   b. Find the modem carrier model from the label.

2. Contact a wireless provider to start service on the modem. Request a data plan with a minimum 10 MB of data per month and SMS. (SMS is optional but required to transmit alarm notifications to an email or mobile number).

   a. Give the MEID or IMEI number to the provider. If requested, give the carrier model, also found on the transmitter label.
   b. Record the data number for the modem.

3. Use the modem diagnostics in FSDATA Desktop to verify operation. Refer to the FSDATA Desktop documentation.

Figure 12   Transmitter Label Examples

TRANSMITTER CONTAINED WITHIN
VERIZON - CDMA2000 1xEV-DO
CARRIER MODEL: MTSMC-EV3-IP-N3
FCC ID: RI7DE910-DUAL
IC CERT#: 5131A-DE910Dual

MEID BARCODE

MEID: XXXXXXXXXXXXX

TRANSMITTER CONTAINED WITHIN
GSM / GPRS
CARRIER MODEL: MTSMC-H5-IP
FCC ID: RI7HE910
IC CERT#: 5131A-HE910

IMEI BARCODE

IMEI: 35157905XXXXXXX

ED_002020B_00036104-00033

Install a SIM card (GPRS only)

NOTICE

Potential Instrument Damage. Delicate internal electronic components can be damaged by static electricity, resulting in degraded performance or eventual failure.

NOTICE

The instrument enclosure can break if the cover screws are over-tightened. Tighten the cover screws by hand with a maximum torque of 2.0 Nm (20 in./lb). Make sure that the gasket is lubricated with grease.

If the instrument contains a GPRS modem, a SIM card from the mobile carrier must be installed. Refer to the illustrated steps that follow.
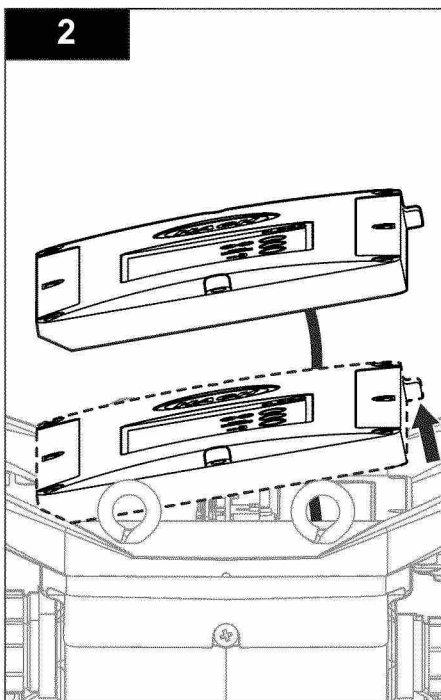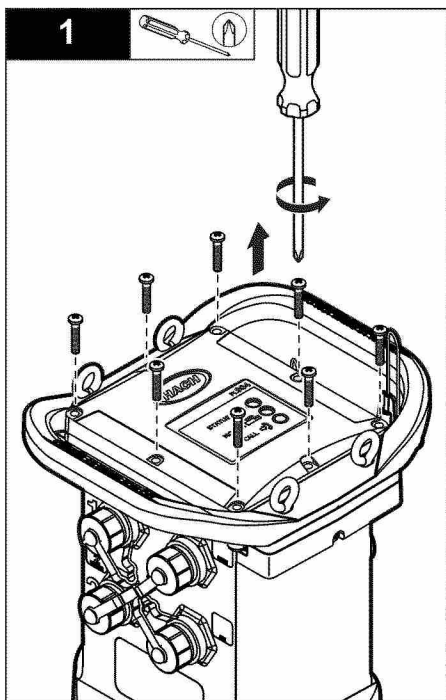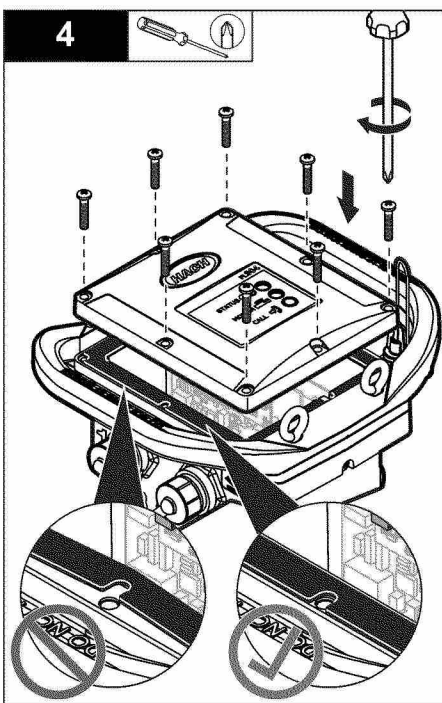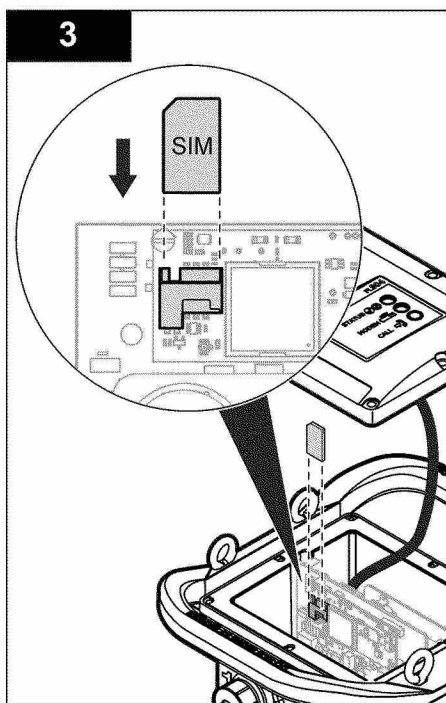
Set up a GPRS modem-based account

Note: If requested, provide the IMEI and modem carrier model found on the transmitter label on the logger.

1. Contact a wireless provider and request an activated SIM card with the following capabilities:
   a. GPRS data
   b. PIN disabled
   c. A minimum of 10 MB of data per month
   d. SMS (optional but required to transmit alarm notifications to an email or mobile number)
2. Record the data number for the modem (APN number).
3. Install the SIM card in the logger. Refer to Install a SIM card (GPRS only) on page 20.
4. Use the modem diagnostics in FSDATA Desktop to make sure that the modem operates correctly.

Attach an antenna (wireless option)

> **⚠ CAUTION**
>
> Electromagnetic radiation hazard. Make sure that the antenna is kept at a minimum distance of 20 cm (7.9 in.) from all personnel in normal use. The antenna cannot be co-located or operated in conjunction with any other antenna or transmitters.

An antenna can be attached to the instrument for wireless communication. Various antenna options are available. Refer to Replacement parts and accessories on page 29. Attach an antenna directly to the logger or attach an antenna cable to the ANTENNA connector (Figure 13).
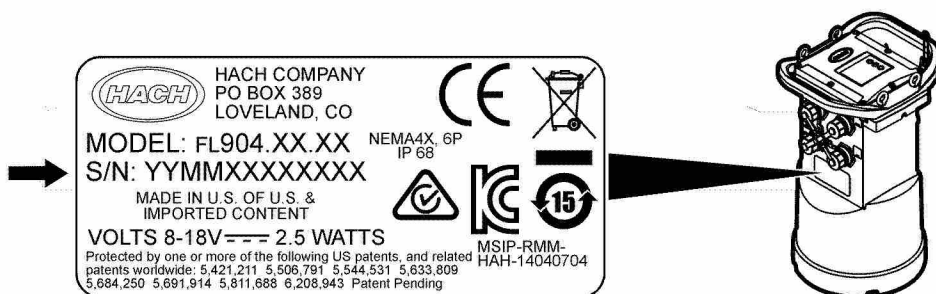
Figure 13 Attach Half-wave antenna
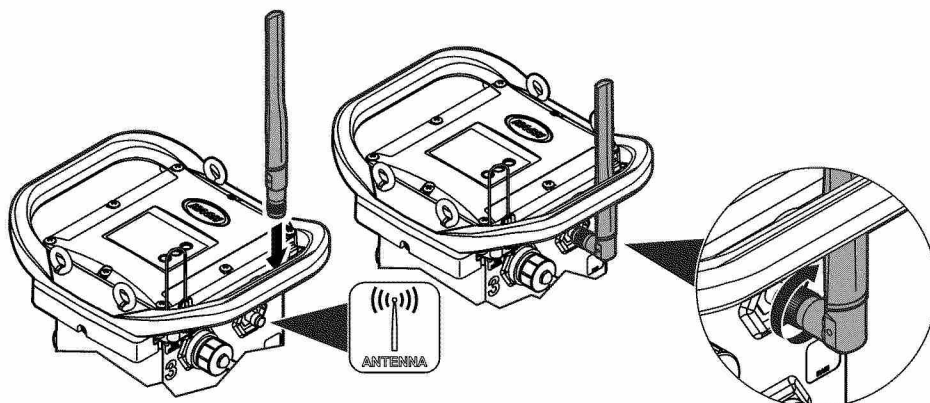
Add the logger to the FSDATA Server

Pre-requisite: Serial number of the logger

Figure 14 Serial number location

HACH COMPANY
PO BOX 389
LOVELAND, CO

MODEL: FL904.XX.XX   NEMA4X, 6P
                       IP 68
S/N: YYMMXXXXXXXX
MADE IN U.S. OF U.S. &
IMPORTED CONTENT
VOLTS 8-18V === 2.5 WATTS
Protected by one or more of the following US patents, and related   MSIP-RMM-
patents worldwide: 5,421,211 5,506,791 5,544,531 5,633,809   HAH-14040704
5,684,250 5,691,914 5,811,688 6,208,943 Patent Pending

NOTICE

Be sure to enter the serial number and SVC correctly to prevent communication failure.

1. Go to the website http://fsdata.hach.com to access the FSDATA server.
2. Enter the user name and password:
   - User name—the default user name is the 8-digit customer ID number
   - Password—the default password is HachWebData
3. Go to **Instruments>Instrument Manager**.
4. Record the SVC (Server Verification Code) from the upper left corner of the screen:

5. Click **ADD NEW**. The Add Instrument window opens.
6. Enter the serial number (SN) of the logger (Figure 14).
7. Select the Instrument Type.
8. Select the Active check box and click **OK**. The instrument is shown in the Instrument Manager.

Configure the logger for remote communication

Pre-requisites: The logger must be attached to the computer. An account with a network provider must be set up, and the server must be configured.

The settings for remote communication must be entered into FSDATA Desktop and then written to the logger.

1. Start a communication session with the logger:

   a. Open FSDATA Desktop.
   b. Click **CONNECT**. The Connect to Instrument window opens.
   c. Click the FL900 button.
   d. Select the port on the computer where the logger is attached (serial or USB), then click **Connect**.
      Note: If the sensor mismatch message is shown, select "Create new program based on sensors connected."
   e. Make sure that the connection status shows "connected".

2. Go to the Communications tab. Enter the information for the desired site. Select Time Zone.

3. Complete the Remote Settings information:

Option	Description
CDMA	No additional configuration is necessary.
GPRS	Select the network provider and the modem frequency. (For US locations, 850/1900 MHz. For outside the US, contact the provider for the modem frequency.) Enter the user name and password, if applicable.
Primary Call Interval	The frequency that the logger calls the server, not to exceed the logging interval.
Secondary call interval	The frequency that the logger calls the server during an alarm condition.
Server Verification Code	The account number that allows a connection to the server.

4. Click **WRITE TO LOGGER** to save the settings. A message window is shown:

Option	Description
Warning: all data will be lost. Continue?	All data that is stored in the logger is erased when a program is written to the logger. To save the data, select No and download the data to a safe location. Select Yes to erase all data and update the logger with the new program.
Set Logger Clock	Synchronize to Computer Clock—the logger uses the date and time settings of the computer. Set Logger Clock—the logger uses the date and time settings that are set by the user. If the unit has a modem, the logger automatically uses the date and time settings of the server.

   A pop up screen will show success or failure.

5. Go to the General Settings tab. Select data log channels and logging intervals.

6. Click **Write to Logger** to save.

Verify the telemetry (wireless option)

The user can manually send a call to the server to make sure that the network communication is good.

1. Temporarily attach the antenna to the logger to test the antenna and the cell coverage at the site location before installation.

2. Touch the magnet to the call initiation target (Figure 15). The modem LED indicator changes to green.

3. Look at the modem LED indicator during the call (45 to 90 seconds) and wait for a change:

   • LED goes off—the call to the server was successful.

- LED flashes red—the call to the server failed.

Note: If the connection failed, refer to Troubleshooting on page 28 for more information.

Figure 15 Call the server
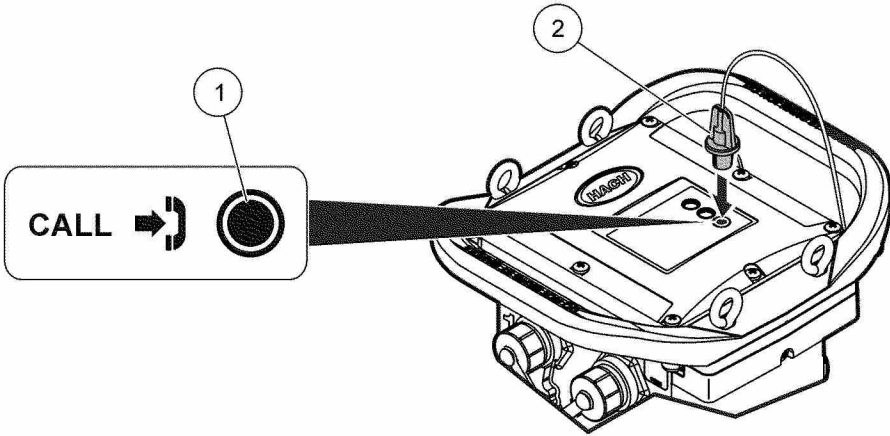
1 Call initiation target	2 Magnet

Verify the telemetry with FSDATA Desktop

1. In FSDATA Desktop, select Communications>Modem Diagnostics.
2. Make sure the registration status is either home or roaming. If blank or "identify" is shown, the connection has failed.
3. Adjust the antenna for optimum signal strength and quality.
4. Click Call Server to make a call to the network.
   A pop up screen will indicate success or failure.

Troubleshooting telemetry

- Make sure the SVC is correct.
- Make sure the serial number is registered and active on the host server.
- Make sure the modem is enabled and the Hach IP address has been correctly entered.
- If the problem persists, contact technical support.

Use the mobile SMS option

Configure the FL900 modem to send or receive SMS messages (optional). Refer to FSDATA Desktop documentation for configuration information.

During a predefined alarm condition (e.g. battery or high level), an SMS message can be sent directly from the logger to an email address or a mobile telephone. This message is sent in addition to the alarm messages that are sent from the server.

A mobile telephone can be used to send an SMS message to the logger (Table 5). The logger looks for new SMS messages during each call to the server. If the message requires a response from the server, the SMS message is forwarded from the logger to the server on the next call.

Table 5 SMS message commands

SMS Command	Action
CURR? or STATUS?	Receive the current status of the FL900 and any sensors connected to it
SVC?	Receive the current value of the Server Verification Code
SVC=XXXXXXXX	To set the current value of the Server Verification Code using a text message

Modbus communication

The Modbus protocol can be used for communication with this instrument. Attach an external network device, such as a PLC, to the RS232 interface on the instrument to read data as it is logged.

Contact technical support for more information on Modbus communications.

Note: Historical data cannot be read with Modbus communication.

Basic setup

The information in this manual can be used to make a simple program for the logger and to calibrate the sensors. Refer to the FSDATA Desktop documentation for advanced options. Complete the sections in the order that they are shown.

Make a basic logger program

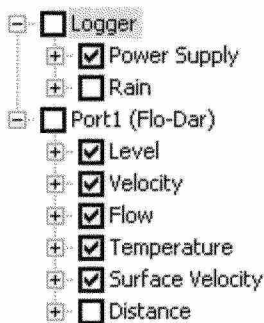A basic program must be written to the logger to specify the channels to be logged.

1. Open a communication session with the logger:

   a. Open FSDATA Desktop.
   b. Click **CONNECT**. The Connect to Instrument window opens.
   c. Click the FL900 button.
   d. Select the port on the computer where the logger is attached (serial or USB), then click **CONNECT**.
      Note: If the sensor mismatch message is shown, select "Create new program based on sensors connected."
   e. Make sure that the connection status shows "connected".

2. Complete the information in the General Settings tab.

Option	Description
Site Identification	Enter a unique name for the site.

3. Select the channels to be logged in the Select channels to log section:

   a. Expand the tree for the Logger channel group. The Power Supply channel is always shown in this group. Logging the power supply will provide values for the battery level. An alarm could be set at a specific level to alert the account manager of a low level, thus prompting a field visit to change the batteries and prevent lost data. If the logger contains a port for a rain gauge, the Rain channel is also shown. To include a Logger channel in the datalog, select the check box next to the channel name.
   b. Expand the tree for each Port[1](Sensor Name) channel group to view the available channels for the sensor. If the check box next to Logger or Port[1] is selected, all of the channels in the group are automatically selected.
   c. To include a Sensor channel in the datalog, select the check box next to the channel name. The log channel count increases each time a channel is selected.

   Note: For loggers with multiple sensor ports, the port number is added to the channel name. For example, Velocity 3 is the velocity channel name for sensor port 3.

```
☐·☐ Logger
   ⊕·☑ Power Supply
   ⊕·☐ Rain
☐·☐ Port1 (Flo-Dar)
   ⊕·☑ Level
   ⊕·☑ Velocity
   ⊕·☑ Flow
   ⊕·☑ Temperature
   ⊕·☑ Surface Velocity
   ⊕·☐ Distance
```

4. To set the logging interval for a channel group:

   a. Click on the channel group name, for example **Port1 (Flo-Dar)**. The logging intervals are shown.
   b. Select the interval from the drop-down list. The primary logging interval is used for normal operation. The secondary logging interval is used during alarm conditions.

   Note: The logging interval cannot be set for an individual sensor channel.

5. Click **WRITE TO LOGGER** to save the settings. A message window is shown:

Option	Description
Warning: all data will be lost. Continue?	All data that is stored in the logger is erased when a program is written to the logger. To save the data, select No and download the data to a safe location. Select Yes to erase all data and update the logger with the new program.
Set Logger Clock	Synchronize to Computer Clock—the logger uses the date and time settings of the computer. Set Logger Clock—the logger uses the date and time settings that are set by the user. If the unit has a modem, the logger automatically uses the date time settings of the server.

Calibrate the sensor with the Cal Wizard

Pre-requisite: The logger must be connected to the computer and must be online for calibration.

The sensor can be configured and calibrated with the calibration wizard.

1. Click the Sensors tab.
2. Click on Sensor Port[1] (sensor name).
3. Click on the **CAL WIZARD** button. The Calibration Wizard window opens.
4. Select the options on each screen. When the Calibration Complete screen is shown, click **FINISH**.
5. Click **WRITE TO LOGGER** to save the settings. A message window is shown:

Option	Description
Warning: all data will be lost, Continue?	All data that is stored in the logger is erased when a program is written to the logger. To save the data, select No and download the data to a safe location. Select Yes to erase all data and update the logger with the new program.
Set Logger Clock	Synchronize to Computer Clock—the logger uses the date and time settings of the computer. Set Logger Clock—the logger uses the date and time settings that are set by the user. If the unit has a modem, the logger automatically uses the date and time settings of the server.

The installation is complete. The Status light should flash green if the programming was successful.

Site installation

Hang from a cable

The logger can hang from a cable for installation in an area such as a manhole.

1. Connect a cable to the eye bolts on the top of the logger. Refer to Figure 16.
2. Hang the cable from a strong support such as an optional spanner bar.

Figure 16 Hang the logger from a cable
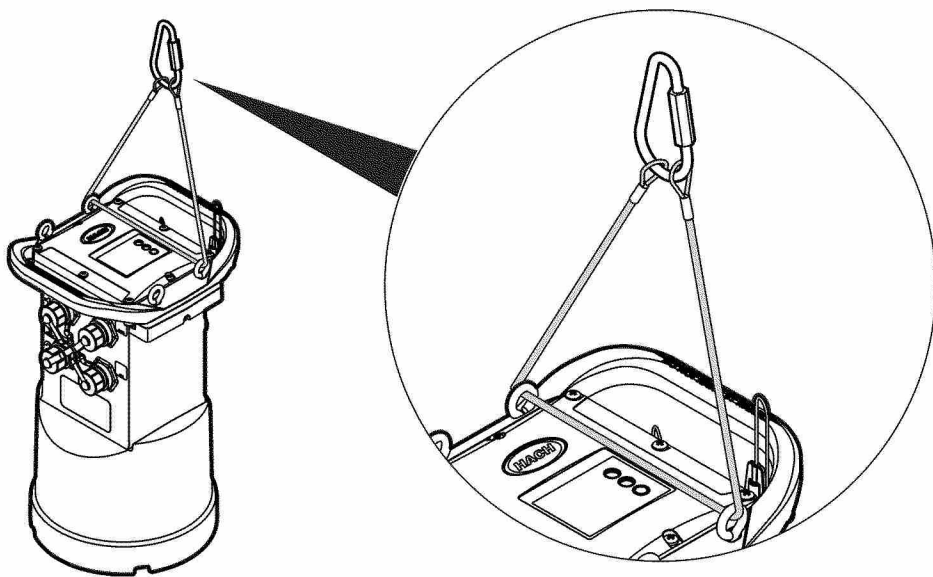
Install on a wall bracket

The logger can be attached to a wall, pole or ladder. Refer to the documents that are supplied with the hardware for installation instructions.

Maintenance

Clean the instrument

Clean the exterior of the instrument with a moist cloth and a mild soap solution and then wipe the instrument dry.

Replace the batteries

Replace the batteries with the same type and rating. Refer to Install the batteries on page 12 and Specifications on page 3.

Replace the desiccant

The desiccant is located in the battery compartment. To remove the battery cover, refer to Install the batteries on page 12. The desiccant absorbs moisture from the air and prevents corrosion to the instrument components. The desiccant beads change color when they become saturated. Replace the desiccant when the beads change from a yellow to a green color (refer to Figure 17). As a best practice, replace the desiccant when the batteries are replaced.

Figure 17 Desiccant replacement
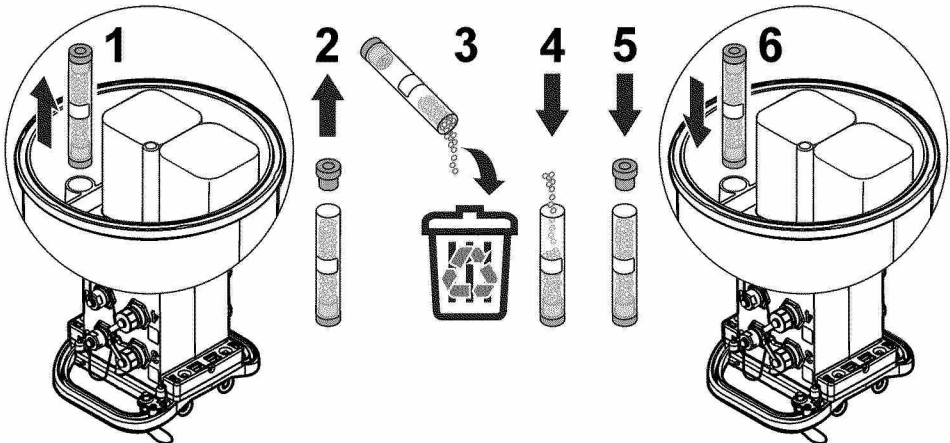
Troubleshooting

If problems occur in the system, try to find whether the problem is with the sensor, the logger or the cable connections.

- Examine all connections to the sensors. Make sure all connections are tight.
- Remove and examine the sensor connectors for moisture. Clean and dry if necessary.
- Examine the sensors for debris and remove the debris.
- Examine the Event Log for problem events.

Communication failure

If a call was sent to the server but the connection failed, complete the following tasks:

• Disconnect and apply power to the instrument.
• Adjust the antenna to increase the signal strength.
• Log on to the server and make sure that the serial number was entered correctly and that the SVC used for configuration was recorded correctly.
• Make sure that the communication settings were entered correctly in the FL900 driver window.
• Connect the logger to the computer and open a communications session. In the FL900 driver window, click on the Diagnostics tab and then the Modem menu. The Registration Status should be Home.
• If there is no resolution, call technical support.

Replacement parts and accessories

Note: Product and Article numbers may vary for some selling regions. Contact the appropriate distributor or refer to the company website for contact information.

Replacement parts

Description	Item no.
Battery compartment cover	8524400
Battery compartment cover, O-ring	8533400
Desiccant cap assembly (battery compartment desiccant)	8754900
Desiccant tube assembly (battery compartment desiccant)	8535200
Desiccant, replacement beads, 680 g (1.5 lb)	8755500
Eyebolts, 1/4–20 x 2.5-in. stainless steel	8535500
Gasket, top cover	8533300
Enclosure screw, #10–14 x 1 in.	8753300
Logger handle	8524200
Lubricant, silicone, 0.25 oz	000298HY
Magnet assembly	8537800
Cap and lanyard for the Sensor, Comm or Aux connectors	8535000
Cap and lanyard for the rain gauge connector	9492500

Cables

Description	Item no.
Cable, external power, 2-wire, 9 ft	8528700
Cable, external power, 2-wire, 25 ft	8528701
Cable, communication, RS232	8528200
Cable, communication, USB	8528300
Cable, connect to sampler, 9 ft	8528400
Cable, connect to sampler, 25 ft	8528401

Power

Description	Item no.
Battery, 6 V lantern	11013M
Battery, long-life alkaline	8542900
Long-life alkaline battery pack top cap adapter and cable	8543000
Cable, power supply adapter (3 pin to 7 pin)	8528600
Power Supply, 110–120 VAC, US plug—requires 8528600 adapter cable	8754500US
Power Supply, 110–120 VAC, EU plug—requires 8528600 adapter cable	8754500EU
Power Supply, 110–120 VAC, UK plug—requires 8528600 adapter cable	8754500UK

Mounting hardware

Description	Item no.
Manhole Support Bracket/Spanner, 18–28 in.	9542
Manhole Support Bracket/Spanner, 28–48 in.	9557
Manhole Support Bracket, 18–27 in.	5713000
Suspension Cable, 16 in.	8544300
Suspension Cable, 30 in. and D-ring (standard)	4920
Wall-mount Bracket with ladder hanger	8544500
Wall-mount Bracket without ladder hanger	8542700
Wall-mount Bracket, adapter	8543800

Antennas

Description	Item no.
Antenna, traffic-rated burial (824–896, 1850–1990 MHz)	8537600
Antenna, half-wave (824–894, 1850–1990 MHz)—US	5228400
Antenna, traffic-rated manhole lid (824–896, 1850–1990 MHz)—US	5255400
Antenna, mini-wing (824–960, 1710–2170 MHz)—US	6241804

External devices

Description	Item no.
Rain Gauge with 100-ft cable	8542800
Connector for legacy rain gauge to FL900	8547700
AV9000 Analyzer Module (required to attach a Submerged Area/Velocity Sensor)	8531300
IM9001 Interface Module (required to attach a Sigma 950 Flow Meter)	8549800
For samplers, refer to www.hach.com for part numbers and accessories	

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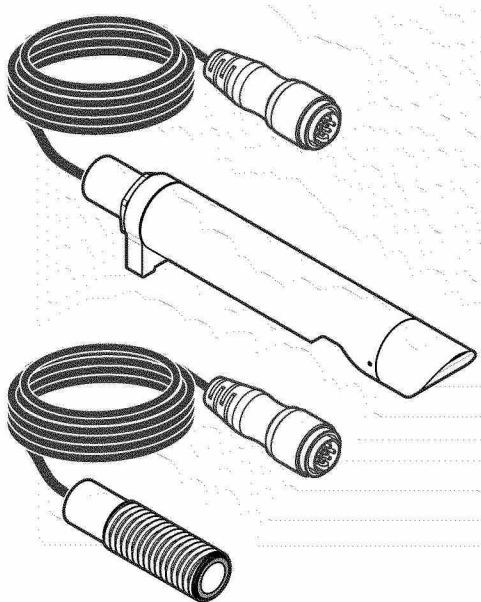
ATTACHMENT 3

**ULTRASONIC
SENSOR USER
MANUAL**

US9001/US9003

User Manual
Manuel d'utilisation
Manual del usuario
Manual do Usuário
用户手册
取扱説明書
사용 설명서

Table of contents

Specifications

Specifications are subject to change without notice.

Specification	Details
Dimensions (∅ x L)	US9001: ∅ 3.02 x 10.31 cm (∅ 1.19 x 4.06 in.) US9003: ∅ 4.06 x 28.04 cm (∅ 1.6 x 11.04 in.)
Enclosure	US9001: 316 stainless steel US9003: 316 stainless steel and ABS
Weight	US9001: 0.76 kg (1.68 lb) with 9.14 m (30 ft) cable US9003: 0.92 kg (2.03 lb) with 9.14 m (30 ft) cable
Mounting	US9001: Wall mount, adjustable arm mount US9003: In-pipe mount
Frequency	120 kHz
Accuracy	0.008 in./in. from the calibration point at steady state temperature, still air and ideal target
Measurement range	US9001: 13.34 to 396.24 cm (5.25 to 156 in.) US9003: 0 to 382.91 cm (0.00 to 150.75 in.)
Power requirements	12 VDC, 0.0416 A, 0.5 W
Operating temperature	–18 to 60 °C (0 to 140 °F)
Operating humidity	0 to 95%, non-condensing
Storage temperature	–40 to 60 °C (–40 to 140 °F)

Specification	Details
Resolution	2.54 mm (0.01 in.)
Cable jacket material	Polyurethane
Cable diameter	6.10 mm (0.24 in.)
Cable length	9.14 m (30 ft), 91.44 m (300 ft) maximum[1]
Beam angle	6 ° (half angle, typical)
Enclosure rating	NEMA 6P, IP 68
Compatible instruments	FL900 series flow loggers
Certifications	CE
Warranty	1 year

[1] Refer to Replacement parts and accessories on page 17 for the extension cables and conduit extension kit.

General information

In no event will the manufacturer be liable for direct, indirect, special, incidental or consequential damages resulting from any defect or omission in this manual. The manufacturer reserves the right to make changes in this manual and the products it describes at any time, without notice or obligation. Revised editions are found on the manufacturer's website.

Safety information

> ### NOTICE
>
> The manufacturer is not responsible for any damages due to misapplication or misuse of this product including, without limitation, direct, incidental and consequential damages, and disclaims such damages to the full extent permitted under applicable law. The user is solely responsible to identify critical application risks and install appropriate mechanisms to protect processes during a possible equipment malfunction.

Please read this entire manual before unpacking, setting up or operating this equipment. Pay attention to all danger and caution statements.

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Failure to do so could result in serious injury to the operator or damage to the equipment.

Make sure that the protection provided by this equipment is not impaired. Do not use or install this equipment in any manner other than that specified in this manual.

Use of hazard information

⚠ DANGER

Indicates a potentially or imminently hazardous situation which, if not avoided, will result in death or serious injury.

⚠ WARNING

Indicates a potentially or imminently hazardous situation which, if not avoided, could result in death or serious injury.

⚠ CAUTION

Indicates a potentially hazardous situation that may result in minor or moderate injury.

NOTICE

Indicates a situation which, if not avoided, may cause damage to the instrument. Information that requires special emphasis.

Precautionary labels

Read all labels and tags attached to the instrument. Personal injury or damage to the instrument could occur if not observed. A symbol on the instrument is referenced in the manual with a precautionary statement.

⚠	This symbol, if noted on the instrument, references the instruction manual for operation and/or safety information.
🗑	Electrical equipment marked with this symbol may not be disposed of in European public disposal systems after 12 August of 2005. In conformity with European local and national regulations (EU Directive 2002/96/EC), European electrical equipment users must now return old or end-of-life equipment to the Producer for disposal at no charge to the user. *Note: For return for recycling, please contact the equipment producer or supplier for instructions on how to return end-of-life equipment, producer-supplied electrical accessories, and all auxiliary items for proper disposal.*

Certification

Canadian Radio Interference-Causing Equipment Regulation, IECS-003, Class A:

Supporting test records reside with the manufacturer.

This Class A digital apparatus meets all requirements of the Canadian Interference-Causing Equipment Regulations.

Cet appareil numèrique de classe A répond à toutes les exigences de la réglementation canadienne sur les équipements provoquant des interférences.

FCC Part 15, Class "A" Limits

Supporting test records reside with the manufacturer. The device complies with Part 15 of the FCC Rules. Operation is subject to the following conditions:

1. The equipment may not cause harmful interference.
2. The equipment must accept any interference received, including interference that may cause undesired operation.

Changes or modifications to this equipment not expressly approved by the party responsible for compliance could void the user's authority to

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operate the equipment. This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference, in which case the user will be required to correct the interference at their expense. The following techniques can be used to reduce interference problems:

1. Disconnect the equipment from its power source to verify that it is or is not the source of the interference.
2. If the equipment is connected to the same outlet as the device experiencing interference, connect the equipment to a different outlet.
3. Move the equipment away from the device receiving the interference.
4. Reposition the receiving antenna for the device receiving the interference.
5. Try combinations of the above.

Product overview

The ultrasonic level sensors are part of the FL900 series flow logger and sensor system. The system measures the flow level and calculates the flow rate in open channels. The flow rate is calculated based on the flow level and the primary device or the flow level and the area velocity supplied by a velocity sensor. When the flow logger is used with an optional modem, flow data collection, programming changes and alarm monitoring can be done remotely.

Status indicator light

When the sensor is connected to a flow logger and taking a reading, the status indicator light of the sensor is on. Refer to Figure 1 on page 6 and Figure 2 on page 6. Refer to Table 1 for the light color descriptions.

Table 1 Status indicator definitions

| Light color	Description
Red	No echo is found (echo loss).
Green	Echo is found.
Flashing green	The measurement target is too near the sensor (within 6.35 mm (0.25 in.) of the sensor minimum distance).

Theory of operation

The flow level is measured by the ultrasonic sensor. The ultrasonic sensor makes a pulsed ultrasound wave which is sent towards the water surface. The ultrasound wave reflects off of the water surface and the echo is received back by the sensor. The distance is the measured time it takes for the ultrasound wave pulse to go from the water surface to the sensor. The measured time is multiplied by the speed of sound at the ambient temperature of the air below the sensor. The sensor measures the ambient temperature for accuracy.

Product components

Make sure that all components have been received. Refer to Figure 1 and Figure 2. If any items are missing or damaged, contact the manufacturer or a sales representative immediately.
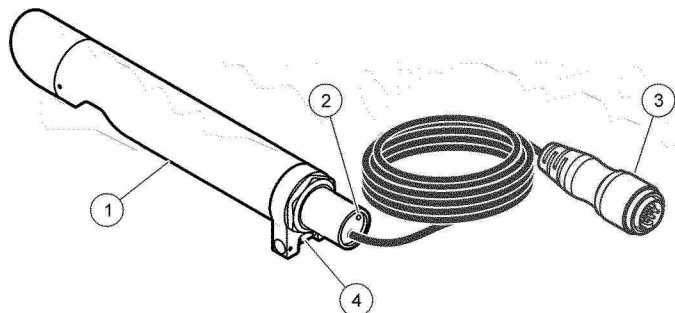
Figure 1 US9001 (downlooking) sensor components
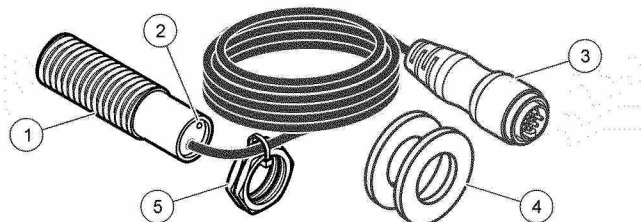
1	US9001 sensor with cable, 9.14 m (30 ft)	4	Gasket, vibration isolation (2x)[1]
2	Status indicator light	5	Hex nut (2x)[1]
3	Connector		

[1] For use with the wall mount bracket (2974) for the downlooking sensor

Figure 2 US9003 (in-pipe) sensor components

1	US9003 sensor with cable, 9.14 m (30 ft)	3	Connector
2	Status indicator light	4	Level

Installation

<table>
<tr><td colspan="2">⚠ C A U T I O N</td></tr>
<tr><td>⚠</td><td>Multiple hazards. Only qualified personnel must conduct the tasks described in this section of the document.</td></tr>
</table>

Site installation guidelines

For the best sensor performance, obey the site installation guidelines in Table 2.

**Table 2 Site installation guidelines**

| Guideline	Details
Do not hang the sensor by the sensor cable.	The sensor cable may stretch and cause measurement errors.
Prevent the sun from shining directly on the sensor.	Intense, direct sunlight on the sensor will increase the temperature of the sensor housing higher than the ambient air temperature. This can cause inaccurate measurements.
For the US9001 (downlooking) sensor, make sure that the lowest mounting nut is more than 6.4 mm (0.25 in.) from the sensor face. Refer to Figure 3.	If the mounting nut is near the sensor face, level spikes can occur at extreme temperatures. Hand tighten the hex nut, then tighten ½ turn. Do not overtighten the hex nut or the isolation gasket will not decrease vibrations.
Prevent strong winds and air currents from blowing directly under the sensor.	The strength of the ultrasonic signal is decreased by the wind.

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Table 2 Site installation guidelines (continued)

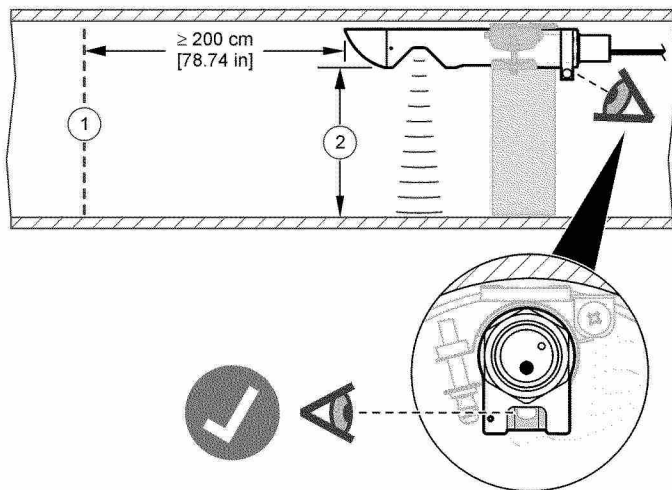| Guideline	Details
Install the sensor so that the ultrasonic signal does not hit the sides of a small pipe or narrow flumes/channels.	The ultrasonic signal emits a half beam angle of 6 °. Refer to Figure 4 and Figure 5. Set the minimum and maximum distance for the measurement target to prevent false echoes and incorrect level measurements. Refer to Change the application settings (optional) on page 15.
Install the sensor sufficiently high above the surface of the water so that it does not go under the water when the level increases.	The speed of sound in water is much faster than in air. A sensor that is under the water will give unusual values.

Figure 3 US9001 (downlooking) sensor

> 0.25 in
[6.35 mm]

1	Hex nut	2	Gasket, vibration isolation
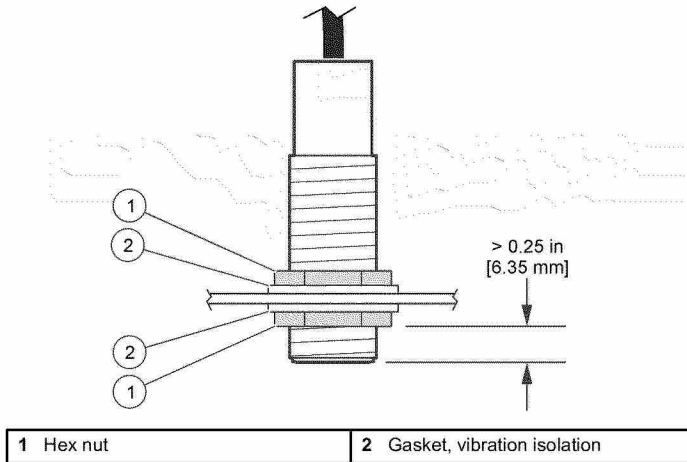
Figure 4 US9001 sensor installation

1	Maximum distance	2	Minimum distance
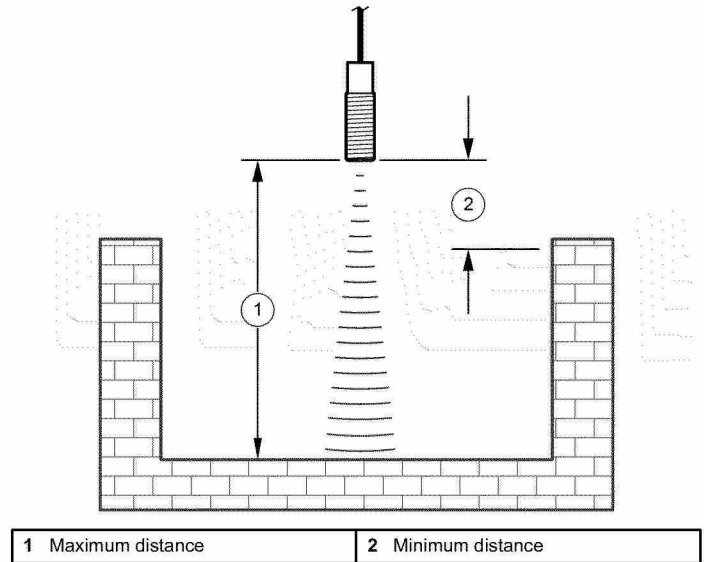
Figure 5 US9003 sensor installation

1	Minimum distance to reflecting obstruction	2	Distance from sensor, 0 to 382.91 cm (0.00 to 150.75 in.) maximum

Install the software

Make sure that the latest version of the Flo-Ware software and the software driver for the FL900 flow logger are installed on the PC or laptop. Download the software driver from http://www.hachflow.com/data-management/software_download.cfm .

Installation setup

From the bottom of the sensor, the ultrasonic signal expands as it moves away from the sensor. Install the sensor so that the ultrasonic signal does not hit the walls of the pipe or the top of the channel.

When the installation is above a narrow channel, do not install the sensor too high because the beam may be wider than the channel. This can cause false echoes from the tops of the channel walls rather than from the water surface. To prevent false echoes, find the applicable sensor height so that the entire beam falls within the channel and does not hit any obstructions.

Select the applicable sensor height:

1. Take the measurements. Refer to Figure 6.
2. Calculate the angle from the axis, Θ = arc tan × (D2/D1) ≈ 80.5 × (D2/D1).
3. To avoid interference from outside obstructions, make sure that the calculated angle from the axis is less than the half beam angle (6 ° typical) of the sensor.

Figure 6 Sensor height selection
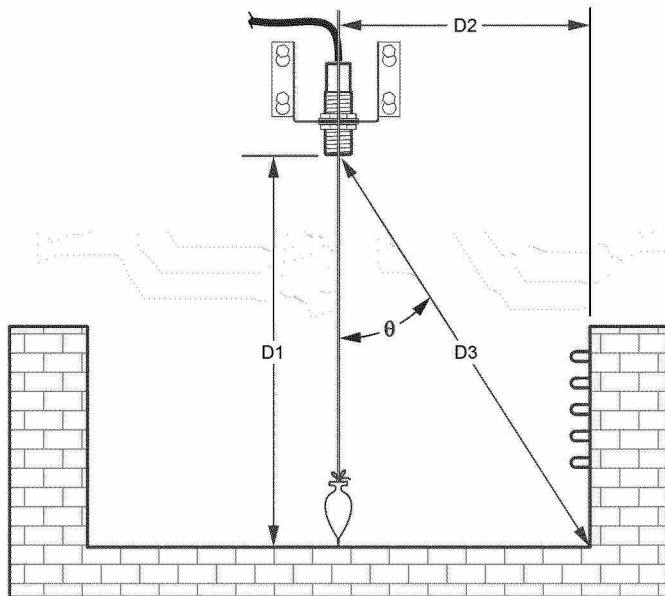
Figure 7 Mounting hardware options – US9001
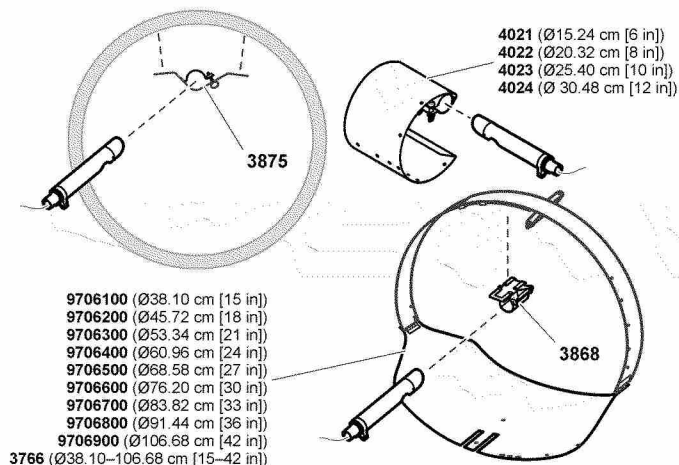

2904   2974
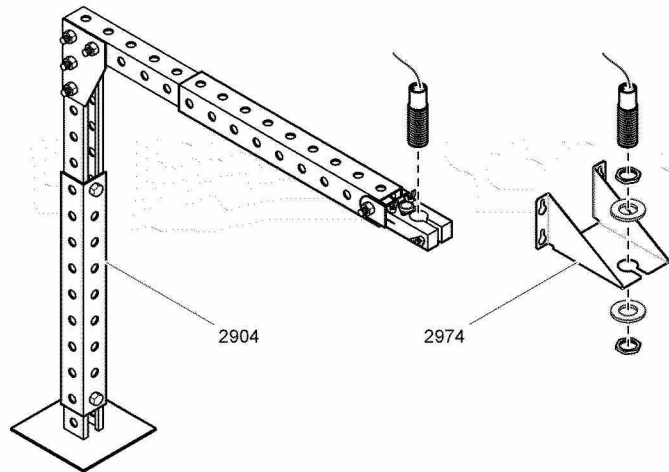
Install the sensor

Install the ultrasonic sensor so that it is over the center of the flow stream and the sensor face is parallel with the flow. The sensor face should be parallel with the flow, so that the signal is perpendicular to the flow and the signal echo does not bounce off the channel walls. The signal bouncing off the wall may cause erratic readings or a complete echo loss.

The ultrasonic sensor has several mounting hardware options. Refer to Figure 7 and Figure 8. Refer to the instructions supplied with the mounting hardware for installation information.

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Figure 8 Mounting hardware options – US9003

4021 (Ø15.24 cm [6 in])
4022 (Ø20.32 cm [8 in])
4023 (Ø25.40 cm [10 in])
4024 (Ø 30.48 cm [12 in])

3875

9706100 (Ø38.10 cm [15 in])
9706200 (Ø45.72 cm [18 in])
9706300 (Ø53.34 cm [21 in])
9706400 (Ø60.96 cm [24 in])
9706500 (Ø68.58 cm [27 in])
9706600 (Ø76.20 cm [30 in])
9706700 (Ø83.82 cm [33 in])
9706800 (Ø91.44 cm [36 in])
9706900 (Ø106.68 cm [42 in])
3766 (Ø38.10–106.68 cm [15–42 in])

3868

Connect to the flow logger

Connect the sensor to the flow logger. Refer to Figure 9.

Figure 9 Connect the sensor to the flow logger
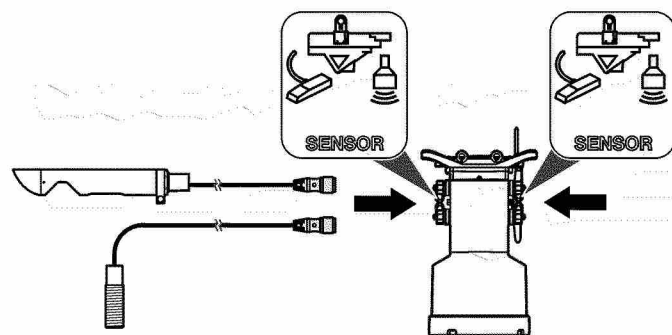
Install the sensor with a primary device

A primary device is a hydraulic structure, such as a flume or weir, that has a known level-to-flow relationship. The ultrasonic sensor measures the level of liquid in a channel that contributes to flow (referred to as the "head") and the flow logger calculates the flow rate based on the head-to-flow relationship of the primary device.

Note: *As an alternative, the flow logger can calculate the flow rate based on the level of liquid in the channel and the area velocity supplied by a velocity sensor. The flow rate calculation method is selected in the Flow Method field.*

Most primary devices have a specific place for the head (liquid level) measurement sensor. Refer to the instructions supplied by the primary device manufacturer for the correct sensor location. When instructions are not available from the primary device manufacturer, refer to Figure 10–Figure 14. The symbol ⊕ in the figures identifies the correct sensor location.

To prevent the sensor from going under water but still have the sensor at the best distance, mount the sensor at the minimum range of the sensor above the typical maximum level of the target. Make sure to be within the maximum range of the sensor and take the minimum level of the target into consideration.
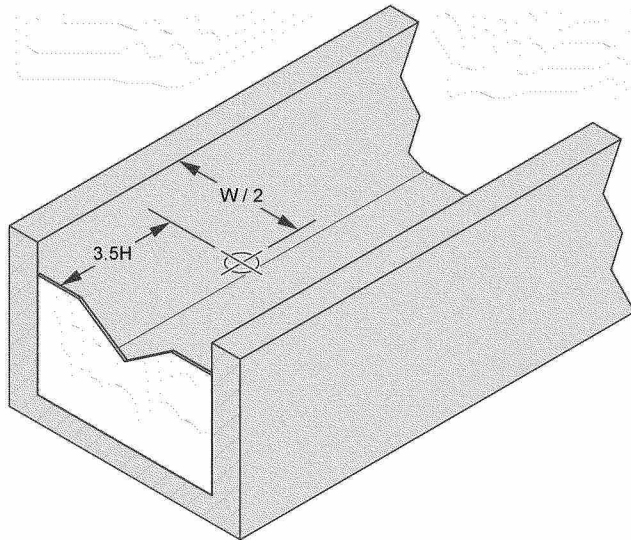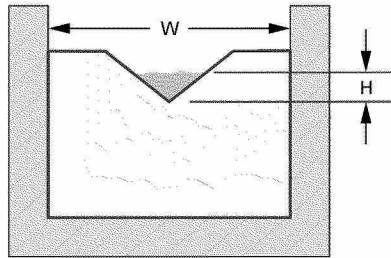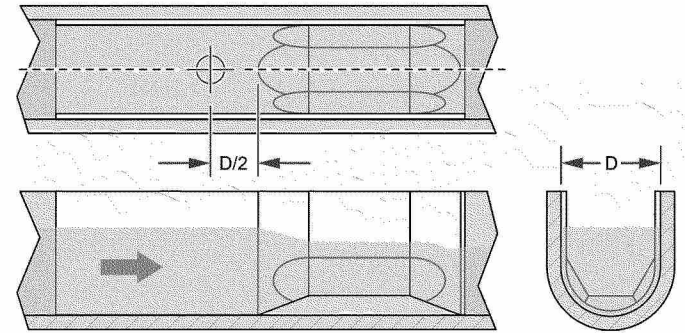
Figure 10 V-notch weir

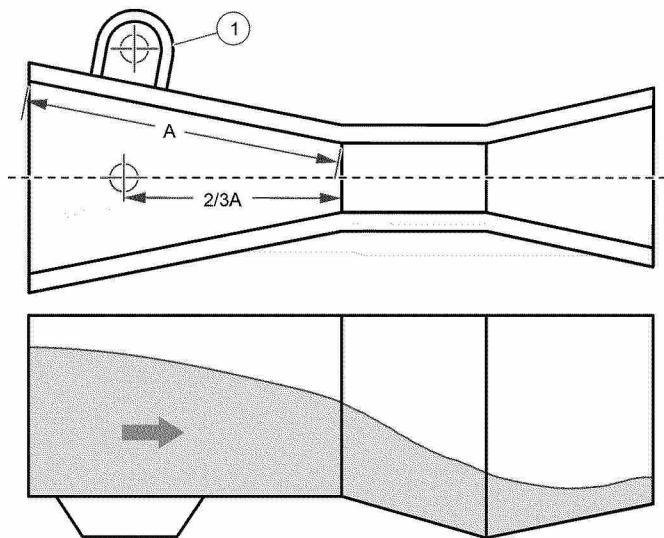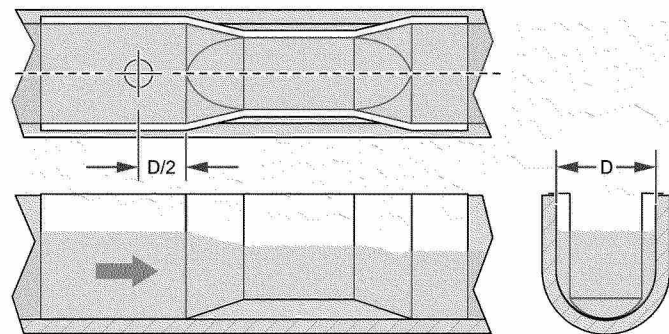**Figure 11 Palmer-Bowlus Flumes**

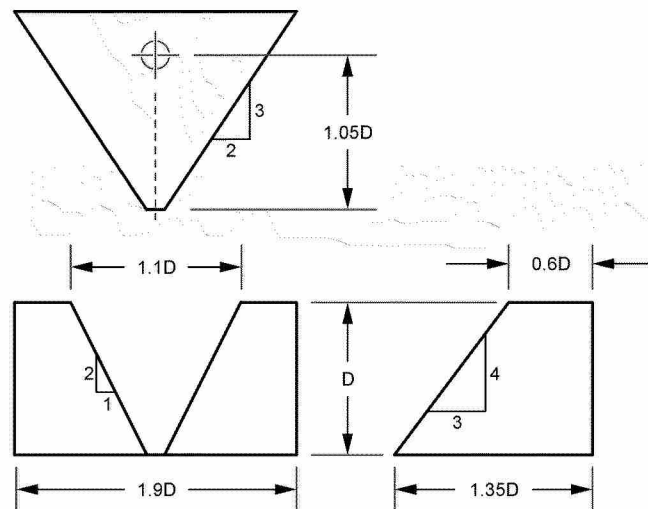## Figure 12 Parshall Flumes

| 1 | Stilling well[1] |

[1] If present, install the sensor in the stilling well. If not, install the sensor in the other location shown.

Figure 13 Leopold-Lagco Flume

Figure 14 H Flume

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Install for a redundant level measurement

The ultrasonic sensors can be used for redundant level measurement, such as with a Sigma area velocity sensor and AV9000 analyzer module, Flo-Dar sensor or Flo-Tote sensor.

The most common example of a redundant level measurement is with the submerged pressure area velocity sensor. The area velocity sensor is typically installed at the base of the pipe on a spring band or scissor band. The ultrasonic sensor is installed at the crown of the pipe. Refer to Figure 15.

Figure 15 Level measurement
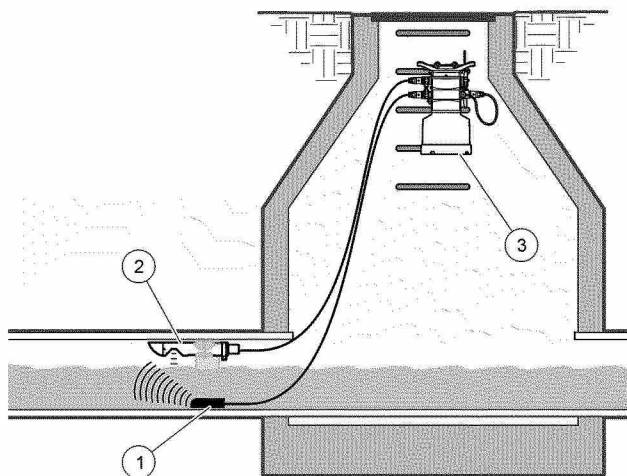
1	Area velocity sensor	3	FL900 logger
2	Ultrasonic sensor		

Operation

Calibration

Go to the US900X configuration screen

1. Make sure that the sensor is attached to the flow logger.
2. Start the Flo-Ware software.
3. Click **Communicate with an instrument**.
4. Select FL900 Series>Communications.
5. Click the **CONNECT** button ▦ to make an online connection to the FL900 series flow logger. A window opens.
6. Select the port on the PC that is connected to the flow logger.
7. Select Modbus RTU in the Protocol field, then click **OK**.
8. Click on the **Programming** tab. If online, the attached sensors and ports show.
9. Select Sensor Port (US900X). The US900X Configuration screen shows.

Calibrate the sensor

Make sure to calibrate the sensor in the operating environment at the typical ambient operating temperature. The temperature of the environment is included in calibration and measurement calculations. The sensor has a 60 minute thermal constant over a 20 °C (36 °F) change in temperature. Give the sensor time to adjust to a large temperature change before calibration.

Use the Flo-Ware software to calibrate the sensor. The sensor can be calibrated with the calibration wizard or manually. Refer to the Flo-Ware manual to calibrate the sensor manually.

To calculate flow with level-area or head-flow tables, calibrate the sensor manually.

Note: Only the level is calibrated unless an area velocity measurement is supplied by a velocity sensor on a separate sensor port of the FL900 series flow logger and that sensor port is selected in the Velocity Input field on the Flow tab.

1. In the Level Unit field, select the measurement units for the level.

ED_002020B_00036104-00059

Note: *The level unit can be different from the logged units that are selected in the Datalog Setup tab.*

2. In the Flow Unit field, select the measurement units for the flow rate.
3. Select the options.

Option	Description
Sensor Type	Select the sensor type—Downlooking or In-Pipe.
Sediment	Enter the level of sediment in the bottom of the channel.
Level Offset (optional)	Enter the difference between the measured level and the actual level. Use to correct an offset error without having to do a calibration.

4. Click **CAL WIZARD**. The Calibration Wizard window opens.
5. Select the options on each screen and click **NEXT**.

Option	Description
Sensor Type	Select the sensor type—Downlooking or In-Pipe.
Flow Method	Select the flow calculation method—area velocity, primary device or None. Select an area velocity option to calculate the flow rate based on the area velocity supplied by a velocity sensor that is connected to the flow logger. Select the type of primary device (e.g., flume or weir) to calculate the flow rate based on the type of primary device. **Note:** *The ultrasonic sensor can be used as a level measurement device only. Select None to not calculate the flow rate.*
Dimensions	Enter the physical parameters of the selected flow calculation method.
Velocity Input	If the flow calculation method selected in the Flow Method field is an area velocity option, select the source of the area velocity input. For example, if an ultrasonic sensor is connected to Port 1 and a submerged area velocity sensor is connected to Port 2, select Port 2 in the Velocity Input field. **Note:** *If a primary device or None is selected in the Flow Method field, the Velocity Input field is disabled.*

Option	Description
Current Level	Enter the flow level in the channel by direct measurement.
Number of Measurements	Select the number of measurements to do during calibration—1, 2 or 3. For more than 1 measurement, Flo-Ware shows the average.

If the calibration was successful, a summary of values shows:

- Distance (downlooking)—the distance from the face of the sensor to the water surface
- Distance (in-pipe)—the distance from the sensor tube to the water surface
- Temperature—the temperature of the operating environment measured by the sensor
- Zero Level Distance—the distance from the face of the sensor or sensor tube to the bottom of the channel
- Echo Loss—the percentage of the ultrasonic signal that was lost during send and receive

6. Click **NEXT**. "Calibration Complete" shows.

Note: *If the calibration was not successful, an error message shows and the sensor takes another measurement.*

7. Click **FINISH**.
8. Click **WRITE TO LOGGER** to save the settings. A window opens.
9. Optional: Select the options.

Option	Description
Set Logger Clock	Set the flow logger clock to the date and time setting of the computer connected to the flow logger. If the flow logger has a modem, the flow logger clock is set to the date and time of the server.
Erase Data	Erase all the data that is kept on the flow logger.

10. Click **OK**.
11. Click the **Flow** tab that is above the Level Settings section. The values entered during calibration show in the fields.

Change the application settings (optional)

The application settings on the Application Settings tab supply more filtering options to manage difficult sites. For most flow conditions, the factory default settings on the Application Settings tab are correct. Contact technical support before changes are made to the application settings.

1. Do the steps in Go to the US900X configuration screen on page 13.
2. Click the Application Settings tab. Select the options.

Option	Description
Filter Size	Select the number of readings the flow logger takes and averages for one data point—1–50 (default = 16).
Reject High	Select the number of the highest values that are discarded—0–49. For example, if the filter size is 16 and the reject high and reject low values are 4, the sensor collects 16 measurements and discards the highest 4 and the lowest 4 measurements. The other 8 values are used to calculate the average data point of level.
Reject Low	Select the number of the lowest values that are discarded—0–49.
Number of Holds	Select the number of times the last recorded data point is saved to the log if a failed reading occurs due to echo loss (default = 5). For example, if the number of holds is 5, the last data point replaces the next 5 consecutive failed readings or until a successful reading occurs.
Median Filter	Select the number of data points that will be used in the flow logger median filter (default = None). The flow logger takes median of 3, 5, 7, 9 or 11 data points to decrease noise or outliers. Only the median values are logged. Raw data values are not logged.
Sample Rate	Select the number of samples taken per second—1–10 (default = 4).

Option	Description
Minimum Distance	Select the minimum distance for the sensor. For the in-pipe sensor, the default is 0. For a downlooking sensor, the default is 5.25 in. Distances less than the minimum distance of the sensor are ignored.
Maximum Distance	Select the maximum distance for the sensor. For the in-pipe sensor, the default is 150.75 in. For a downlooking sensor, the default is 156.00 in. Distances more than the maximum distance of the sensor are ignored.

3. Click **WRITE TO LOGGER** to save the settings.

Note: To change the configuration settings to the factory defaults, click **RESTORE DEFAULTS**.

Set up the Datalog settings

Select the sensor measurements that are logged.

1. Do the steps in Go to the US900X configuration screen on page 13.
2. Click the **Datalog Setup** tab.
3. Click the "+" symbol to the left of Port (US900X). Check boxes show. Select a check box to log that measurement. For example, select Flow to log the flow rate.
4. Click **WRITE TO LOGGER** to save the settings.
5. Click **OK**.

Maintenance

⚠ CAUTION

Personal injury hazard. Only qualified personnel should conduct the tasks described in this section of the manual.

NOTICE

Do not disassemble the instrument for maintenance. If the internal components must be cleaned or repaired, contact the manufacturer.

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Clean the sensor

NOTICE
Do not use steel wool or abrasive pads to clean the sensor or sensor damage will occur.

Examine the sensor periodically for unwanted material and deposits. Clean the sensor when there is a buildup of deposits or when performance has decreased. Table 3 shows the cleaning solutions to use and not to use.

Table 3 List of cleaning solutions

Use	Do not use
Dish detergent and water	Products that contain ammonia
	Concentrated bleach
	Kerosene
	Gasoline
	Aromatic hydrocarbons

1. Disconnect the sensor from the flow logger.
2. Soak the sensor in dish detergent and water.
3. Clean the sensor face and reflector.
4. Use a spray bottle or squeeze bottle to remove heavier unwanted material.

Troubleshooting

Problem	Possible cause	Solution
Echo loss	Foam or condensing moisture (steam or fog) which absorbs the ultrasonic signal	Install the sensor in a location with no foam or condensing moisture.
	High wind such as air currents in a closed high velocity sewer system or wind gusts during a storm	Keep wind away from the sensor. Contact technical support for ideas for specific environments.
	The sensor face is not parallel with the surface of the measurement target.	Make sure that the sensor face is parallel with the surface of the measurement target.
	The surface of the measurement target is not good (extreme turbulence).	Select a different area to measure the target.

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Problem	Possible cause	Solution
Inaccurate measurements	The pipe or channel where the sensor is installed is small or too narrow. The ultrasonic signal bounces off the sides of the pipe or channel.	Install the sensor in a larger diameter pipe or move the sensor nearer to the water surface. Keep the downlooking sensor a minimum of 13.34 cm (5.25 in.) from the water surface. Keep the in-pipe sensor a minimum of 0 cm (0 in.) from the water surface. As an alternative, increase the minimum distance value to a location below the false target that is affecting measurements.
	The sensor is in direct sunlight.	Do not let the sun shine directly on the sensor. Make a sun-shield if an alternative location is not available. Contact technical support for ideas for the specific environment.
	The temperature of the sensor environment has changed quickly.	Let the sensor stabilize after large changes in the temperature of the environment.
	The sensor is too far away from the surface of the measurement target.	Install the sensor near the surface of the measurement target.
Measurement failure	Foam, oil, debris and surface turbulence are affecting the send and receive signal.	Clean the sensor. Refer to Clean the sensor on page 16.

Replacement parts and accessories

> ⚠ **WARNING**
>
> ⚠ Personal injury hazard. Use of non-approved parts may cause personal injury, damage to the instrument or equipment malfunction. The replacement parts in this section are approved by the manufacturer.

Note: *Product and Article numbers may vary for some selling regions. Contact the appropriate distributor or refer to the company website for contact information.*

Replacement parts

Description	Item no.
Gasket, vibration isolation	6820
Holder (level) for US9003 (in-pipe) sensor	9488700

Accessories

Description	Item no.
Extension cable with connectors, 15.24 m (50 ft)	9489000
Extension cable, 82.29 m (270 ft), bare wire one end, cable only	9488100
Extension kit for conduit, includes: 82.29 m (270 ft) cable with bare wires and junction box with 30.48 cm (12 in.) cable and connector to logger **Note:** *Order the ultrasonic sensor, dispensing gun, and gel cartridges separately.*	9488000
Gel cartridges (3x) with feed tubes, for the junction box (if used) to keep water out	7725600
Gel cartridge, dispensing gun	7715300
Junction box with 30.48 cm (12 in.) cable, connector and karabiner clip **Note:** *Order the dispensing gun and gel cartridges separately.*	9488200
Mounting bracket, permanent, for US9003 (in-pipe) sensor	3875
Mounting bracket, floor or wall, adjustable, for US9001 (downlooking) sensor	2904
Mounting bracket, wall, permanent, for US9001 (downlooking) sensor	2974
Mounting clip for US9003 (in-pipe) sensor	3868

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Replacement parts and accessories (continued)

Description	Item no.
Scissor band set for ⌀ 38.10 to 106.68 cm (15 to 42 in.) pipe for US9003 (in-pipe) sensor	3766
Scissor band for ⌀ 38.10 cm (15 in.) pipe	9706100
Scissor band for ⌀ 45.72 cm (18 in.) pipe	9706200
Scissor band for ⌀ 53.34 cm (21 in.) pipe	9706300
Scissor band for ⌀ 60.96 cm (24 in.) pipe	9706400
Scissor band for ⌀ 68.58 cm (27 in.) pipe	9706500
Scissor band for ⌀ 76.20 cm (30 in.) pipe	9706600
Scissor band for ⌀ 83.82 cm (33 in.) pipe	9706700
Scissor band for ⌀ 91.44 cm (36 in.) pipe	9706800
Scissor band for ⌀ 106.68 cm (42 in.) pipe	9706900
Spring ring, ⌀ 15.24 cm (6 in.), for US9003 (in-pipe) sensor	4021
Spring ring, ⌀ 20.32 cm (8 in.), for US9003 (in-pipe) sensor	4022
Spring ring, ⌀ 25.40 cm (10 in.), for US9003 (in-pipe) sensor	4023
Spring ring, ⌀ 30.48 cm (12 in.), for US9003 (in-pipe) sensor	4024

ED_002020B_00036104-00064

U.S. and countries other than EU
HACH COMPANY
P.O. Box 389, Loveland, CO 80539-0389 U.S.A.
Tel. (970) 622-7120
Tel. (800) 368-2723
Fax (970) 619-5150
hachflowsales@hach.com
www.hachflow.com

Marsh-McBirney and Sigma Flow
Products (except Sigma Flow
Products in France and the UK)
FLOWTRONIC, SA.
Rue J.H. Cool 19a
B-4840 Welkenraedt, Belgium
Tel. +32 (0) 87 899 799
Fax +32 (0) 87 899 790
www.flow-tronic.com

France and UK
(Sigma Flow Products Only)
HACH LANGE GmbH
Willstätterstraße 11
D-40549 Düsseldorf, Germany
Tel. +49 (0) 211 5288-0
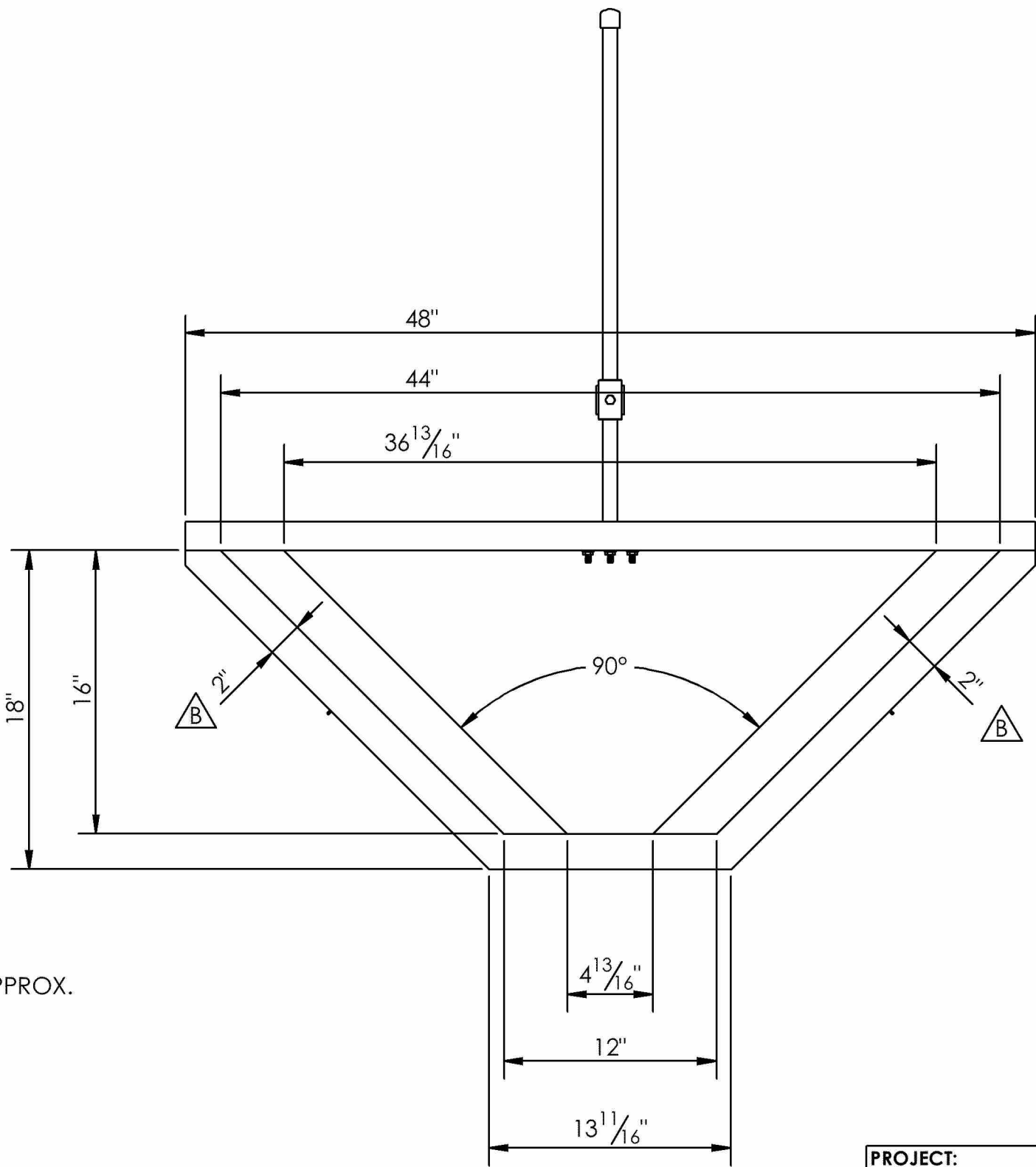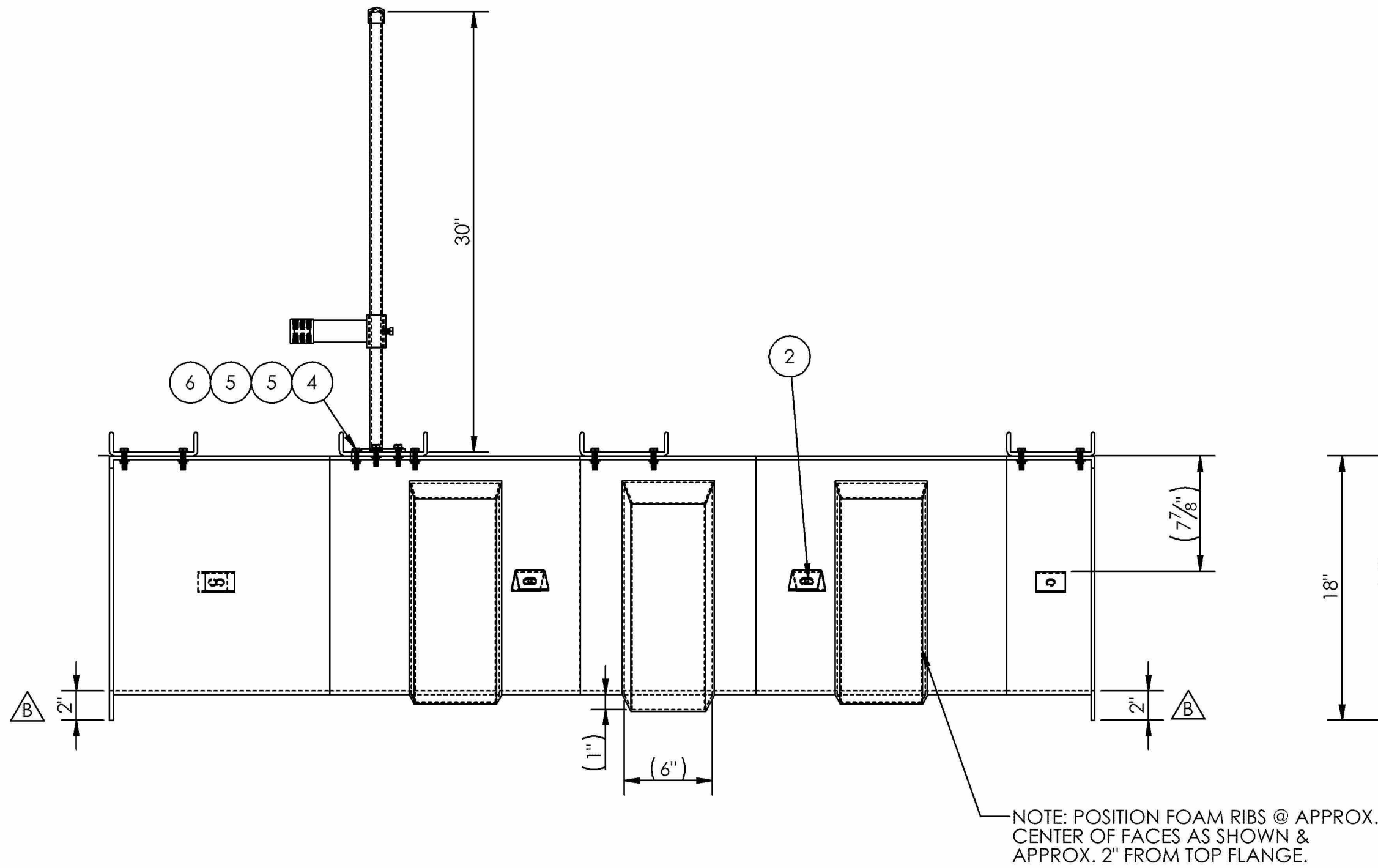Fax +49 (0) 211 5288-143
E-mail: info@hach-lange.de
www.hach-lange.com

ATTACHMENT 4
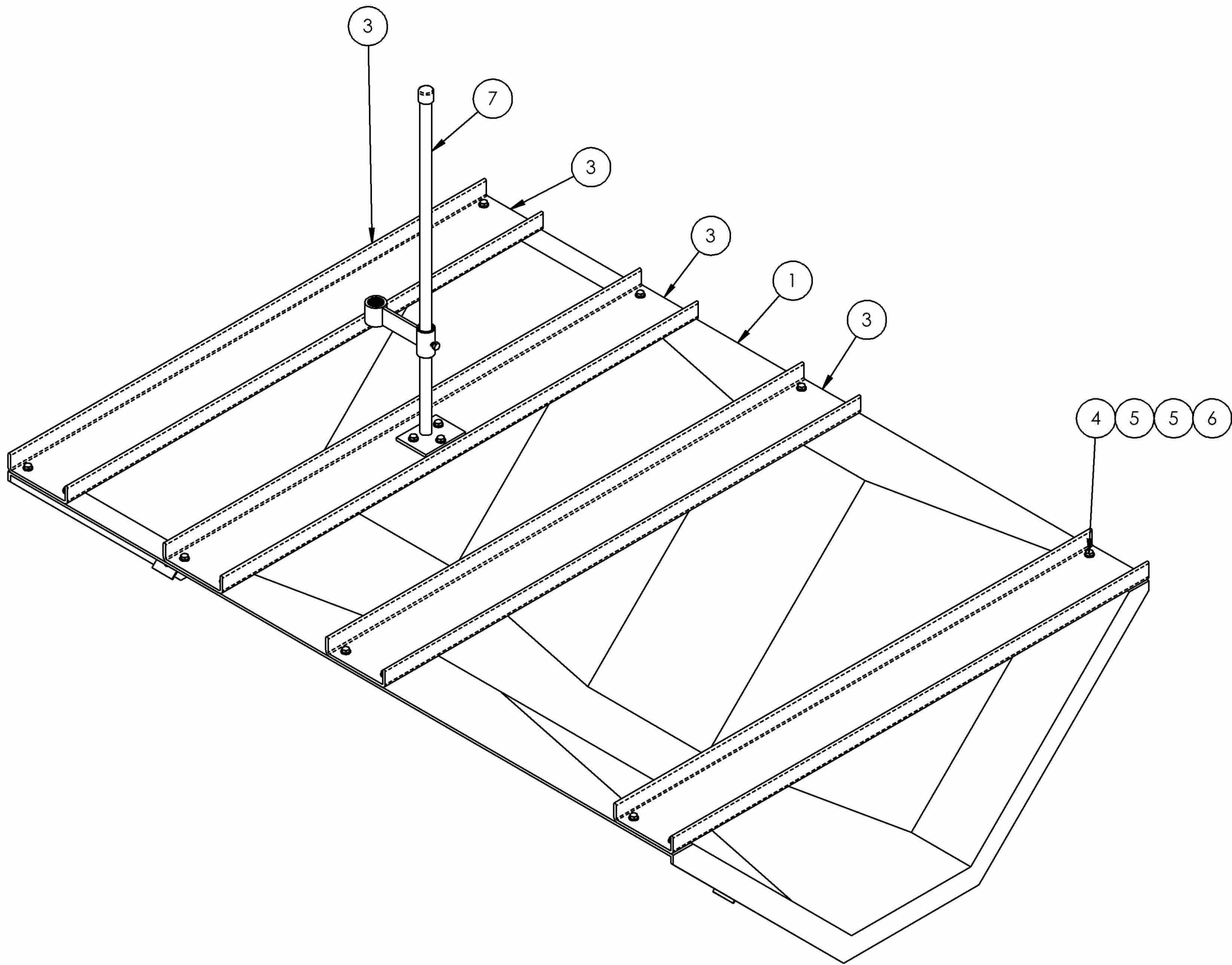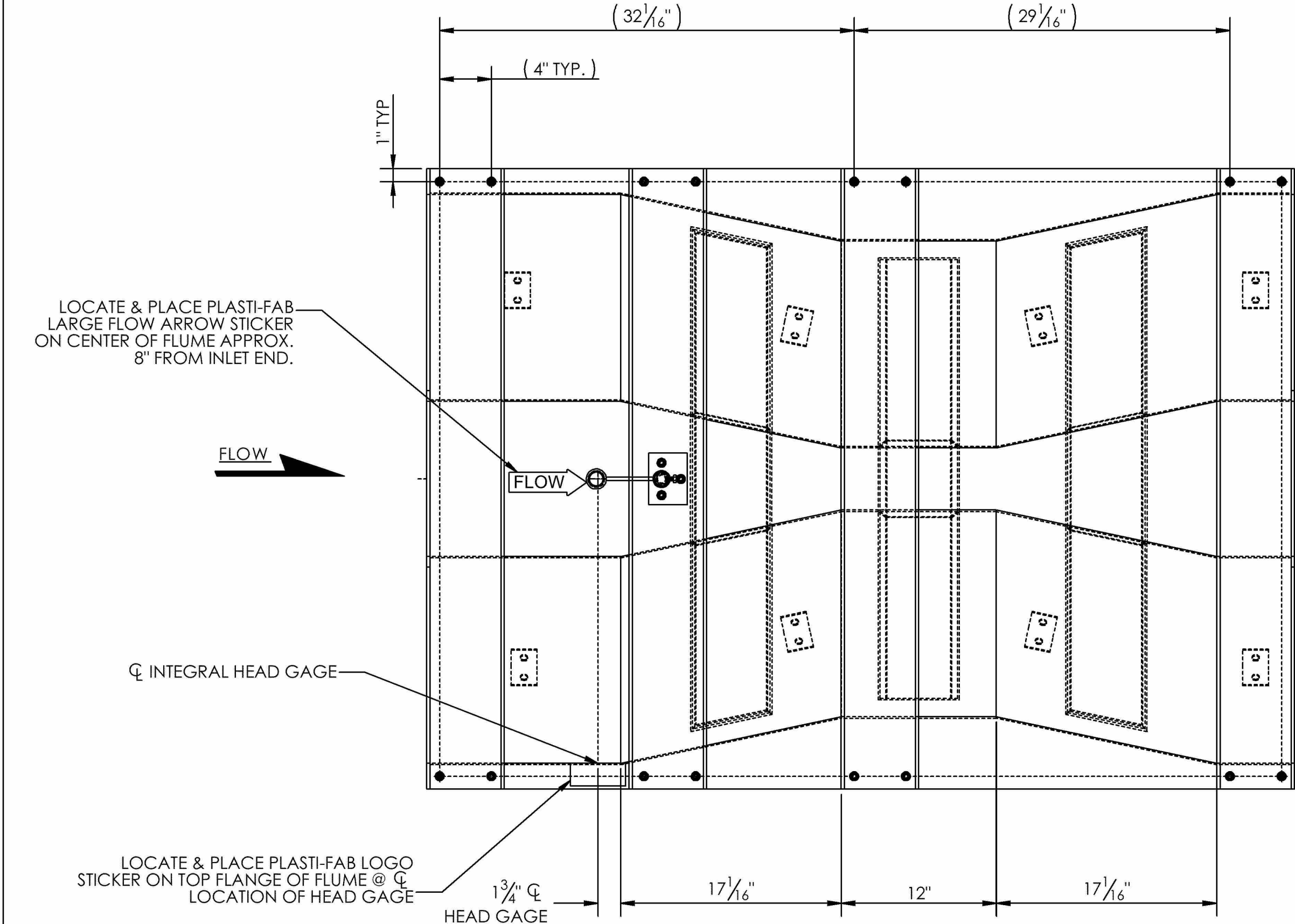
TRAPEZOIDAL
FLUME CUT SHEET

REVISIONS

REV.	DESCRIPTION	NCR/ECO NO.	REVISED BY	DATE
A	FOR APPROVAL		A. PATTERSON	2/24/15
B	PER CLIENT; REVISED FRONT AND REAR FLANGES TO MEASURE 2" ALL AROUND.		A. PATTERSONC2	2/25/2015

LOCATE & PLACE PLASTI-FAB LARGE FLOW ARROW STICKER ON CENTER OF FLUME APPROX. 8" FROM INLET END.

FLOW

₵ INTEGRAL HEAD GAGE

LOCATE & PLACE PLASTI-FAB LOGO STICKER ON TOP FLANGE OF FLUME @ ₵ LOCATION OF HEAD GAGE

HEAD GAGE

FLOW

NOTE: POSITION FOAM RIBS @ APPROX. CENTER OF FACES AS SHOWN & APPROX. 2" FROM TOP FLANGE.

NOTES:
1. THE MINIMUM THICKNESS IS 1/4" FRP (FIBERGLASS REINFORCED PLASTIC).
2. THE INSIDE SURFACE IS SMOOTH WHITE GEL COAT.
3. MINIMUM GLASS CONTENT IS 30%, EXCLUSIVE OF RESIN RICH SURFACES.
4. THE INLET HEAD GAGE (100THS OF A FOOT & CM) IS MOLDED INTO THE SIDE OF THE FLUME.
5. ALL BOLTS, NUTS, AND WASHERS ARE TYPE 304 STAINLESS STEEL.
6. RESIN: CCP STYPOL C1-1200-22.

BOM TABLE

ITEM NO.	QTY.	DESCRIPTION	MATERIAL	LENGTH	PART NUMBER
1	1	12" X 45° SRCRC TRAPEZOIDAL FLUME	FRP (HLU, POLYESTER)		TRAP01245SRCRC-001
2	8	2" KEYTAB CLIP W/ 9/16" HOLES	A36		410-0007
3	4	CHANNEL, 6" X 1 5/8" X 1/4"	FRP (PULTRUDED, POLYESTER)	48"	313-0002
4	19	HHCS, 5/16-18UNC X 1 1/4"	T-304 S/S		661-0013
5	38	5/16 FLAT WASHER	T-304 S/S		664-0029
6	19	HEX NUT, 5/16-18UNC	T-304 S/S		663-0001
7	1	SONIC BRACKET ASSEMBLY, 3/4" NPT, 30" HIGH	T-304 S/S		1000-0005

PROJECT:
MONKEY SPRING FLOW MONITORING
TUCSON, AZ USA

CUSTOMER:
GOBLE SAMPSON

REP:
GOBLE SAMPSON ASSOC., INC.

P.O NO: PO04603

Plasti-Fab®
TUALATIN, OR.

PLASTI-FAB PART NUMBER:
FLUM-1280-1

MATERIAL INFORMATION:

SPECIAL FINISH REQUIREMENT:

UNLESS OTHERWISE SPECIFIED, DIMENSIONS ARE IN FEET/INCHES

TITLE:
12" X 45° SRCRC TRAPEZOIDAL FLUME ASSEMBLY

PROPRIETARY AND CONFIDENTIAL
THE INFORMATION CONTAINED IN THIS DRAWING IS THE SOLE PROPERTY OF PLASTI-FAB. ANY REPRODUCTION IN PART OR AS A WHOLE WITHOUT THE WRITTEN PERMISSION OF PLASTI-FAB IS PROHIBITED.

TOLERANCES UNLESS OTHERWISE SPECIFIED.

TOLERANCES UNLESS OTHERWISE SPECIFIED.	
≤ 6'-0"	± 1/16"
> 6'-0" AND ≤ 25'-0"	± 1/8"
> 25'-0"	± 1/2"

NAME:	DATE:	SIZE	DRAWING NO.:	REV.
DRAWN BY: A. PATTERSON	2/24/2015	**D**	FLUM-1280-1	**B**
CHECKED BY:		WEIGHT: 101	SCALE: 1:8	SHEET: 1 OF 1

ATTACHMENT 5

NEMA
ENCLOSURE
DATA SHEET

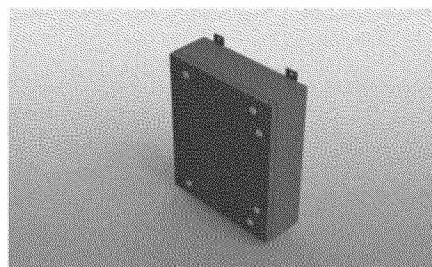# Wall-Mount Type 4 Enclosure,W/Back Panel 24x24x12

REQUEST A QUOTE »

Features

- Includes Powder Coated Back Panel
- Ships in 15 Days
- All Stainless Steel Hardware
- ANSI 61 Grey Powder Coat Finish Interior and Exterior
- Collar Mounting Studs for back panels
- Ground Studs provided on the interior of the enclosure and door
- UL Listed per UL File Number E130533/IP66
- Internal Print Pocket (ships loose)

$265.10   Qty: [0]   BUY NOW »

ASK A QUESTION

Full Name *

Email *

Phone

Attach A File
Choose File   No fil...hosen

Comment *

DESIGNABOX™

CUSTOMIZE »

DESIGNABOX™, the innovative online productivity tool from Nema Enclosures. It allows you to take charge in customizing a standard enclosure, from junction boxes to freestanding, to meet your exact job requirements. DESIGNABOX™ integrates seamlessly into our proprietary manufacturing process which allows us to reach the fastest delivery of custom enclosures on the market. DESIGNABOX™doesn't require AutoCAD or SOLIDWORKS software to use – simply an internet connection. In Beta. Patent Pending.

My Cart

You have no items in your shopping cart.

DOWNLOAD STEP (/MEDIA/FILES/STEP/CHD242412WP.STEP)

DOWNLOAD PDF (/MEDIA/FILES/PDF/CHD242412WP%203D.PDF)

DOWNLOAD DXF (/MEDIA/FILES/DXF/CHD242412WP%20DXF.DXF)

Notes:

*For Internet Explorer, right-click and choose "Save Target As..." to download the STEP and DXF files.

*PDFs downloaded in Google Chrome or Firefox must be opened using Adobe Acrobat. Opening the PDF in Google Chrome or Firefox browser windows disables the 3D functionality.

*Contact us for better volume pricing and lead time on quantities of 10 or more.

Specifications	Features
SKU	CHD242412WP
Weight (lbs.)	53.0000
Enclosure Type	Wall Mount
Enclosure Material	Powder Coated Carbon Steel
Enclosure Feature	Concealed Hinge 1/4 Turn Latch
Door	Single Door
Height	24
Width	24
Depth	12
Nema Rating	4
IP Rating	N/A
Back Panel	Carbon Steel
2D CAD Drawing	CHD242412WP DXF
3D PDF Drawing	CHD242412WP 3D
3D Step Drawing	CHD242412WP.STEP

Wall-Mount Type 4 Enclosure,W/Back Panel 24x24x12

REQUEST A QUOTE »

Features

- Includes Powder Coated Back Panel
- Ships in 15 Days
- All Stainless Steel Hardware
- ANSI 61 Grey Powder Coat Finish Interior and Exterior
- Collar Mounting Studs for back panels
- Ground Studs provided on the interior of the enclosure and door
- UL Listed per UL File Number E130533/IP66
- Internal Print Pocket (ships loose)

$265.10   Qty: 0   BUY NOW »

ASK A QUESTION

Full Name *

Email *

Phone

Attach A File

Choose File   No fil...hosen

Comment *

DESIGNABOX™   CUSTOMIZE »

DESIGNABOX™, the innovative online productivity tool from Nema Enclosures. It allows you to take charge in customizing a standard enclosure, from junction boxes to freestanding, to meet your exact job requirements. **DESIGNABOX™** integrates seamlessly into our proprietary manufacturing process which allows us to reach the fastest delivery of custom enclosures on the market. **DESIGNABOX™** doesn't require AutoCAD or SOLIDWORKS software to use – simply an internet connection. In Beta. Patent Pending.

My Cart

You have no items in your shopping cart.

DOWNLOAD STEP (/MEDIA/FILES/STEP/CHD242412WP.STEP)

DOWNLOAD PDF (/MEDIA/FILES/PDF/CHD242412WP%203D.PDF)

DOWNLOAD DXF (/MEDIA/FILES/DXF/CHD242412WP%20DXF.DXF)

Notes:

*For Internet Explorer, right-click and choose "Save Target As..." to download the STEP and DXF files.

*PDFs downloaded in Google Chrome or Firefox must be opened using Adobe Acrobat. Opening the PDF in Google Chrome or Firefox browser windows disables the 3D functionality.

*Contact us for better volume pricing and lead time on quantities of 10 or more.

Specifications	Features

- Includes Powder Coated Back Panel
- Ships in 15 Days
- All Stainless Steel Hardware
- ANSI 61 Grey Powder Coat Finish Interior and Exterior
- Collar Mounting Studs for back panels
- Ground Studs provided on the interior of the enclosure and door
- UL Listed per UL File Number E130533/IP66
- Internal Print Pocket (ships loose)

ATTACHMENT 6

PV MODULE
DATA **S**HEET

SPS
Solar Panel Store
Everything you need to go Solar!
www.solarpanelstore.com

J-Series
20W PV Module
SPM020P-BP

Solartech J-Series Modules

Solartech photovoltaic J-Series Modules are constructed with high efficient polycrystalline solar cells and produce higher output per module than others in it class. This industrial grade module is an industry standard among various industry professionals.

Features

· Accessible junction box with 4-1/2 knockout for ease of installation.
· (EVA) with TPT cushions the solar cells within the laminate an ensures the operating characteristics of the solar cells under virtually any climatic condition
· Rigid anodized aluminum frame and low iron tempered glass
· Easily accessible grounding points on all four corners for fast installation
· Proven junction box technology
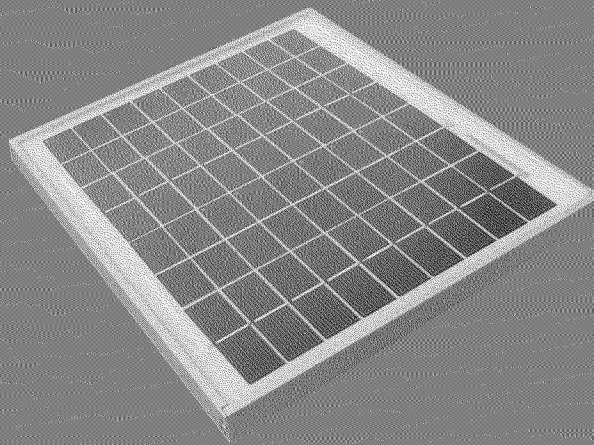
Reliability

· Proven superior field performance
· Tight power tolerance

Qualifications and Certifications

△ TÜV   IEC   ETL c US LISTED   UL c US LISTED

UL No.: E330673 TUV No.:0000022551 IEC No.:C1-ASN07001 ETL No.:4001057

Applications

· Traffic & Safety
· Federal Government
· Oil & Gas
· Security
· Telecommunications
· Water and Wastewater
· Weather & Environmental Monitoring
· RV Camper
· Emergency Power
· Telemetry
· SCADA, RTU, GPS
· Marine
· Area Lighting & Sign

Electrical Characteristics

Max power(Pm)	20W
Maximum power voltage(Vpm)	16.8V
Maximum power current (Ipm)	1.19A
Short circuit current (Isc)	1.29A
Open circuit voltage (Voc)	21.0V
Module efficiency	9.4%
Tolerance	±5%
Nominal Voltage	12V
Temperature coefficient of Voc	-0.36%/K
Temperature coefficient of Pm	-0.46%/K
Temperature coefficient of Isc	0.05%/K
NOCT	48℃±2℃
Maximum series fuse rating	10A
Maximum system voltage	1000V

Mechanical Characteristics

|	
Construction	Tempered glass, silicon cell, EVA, Polyester with Tedlar
Solar Cells	36 cells (156mm x 26mm) in a 3x12 matrix connected in series
Front Cover	High transmission 3.2mm(1/8") glass
Encapsulant	EVA(Double layers)
Back Cover	White polyester
Frame	Anodized aluminum
Junction Box	IP65, UL94-5VA material
Diodes	Schottky by-pass diodes
Terminal	Accept 8-14 AWG wire
Dimensions	16.5in(419mm)x19.8in(502mm)x1.97in(50mm)
Weight	7.26lb (3.3kg)
Operating Temperature	-40℃~90℃
Storage Humidity	<90%

IV Curves
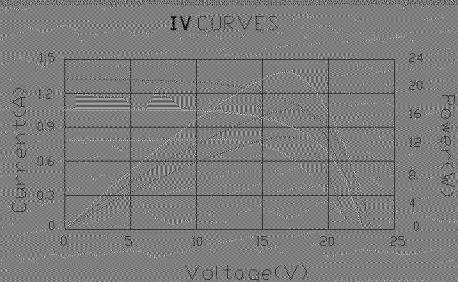
Warranty

25-year limited warranty of 80% power output;
12-year limited warranty of 90% power output;
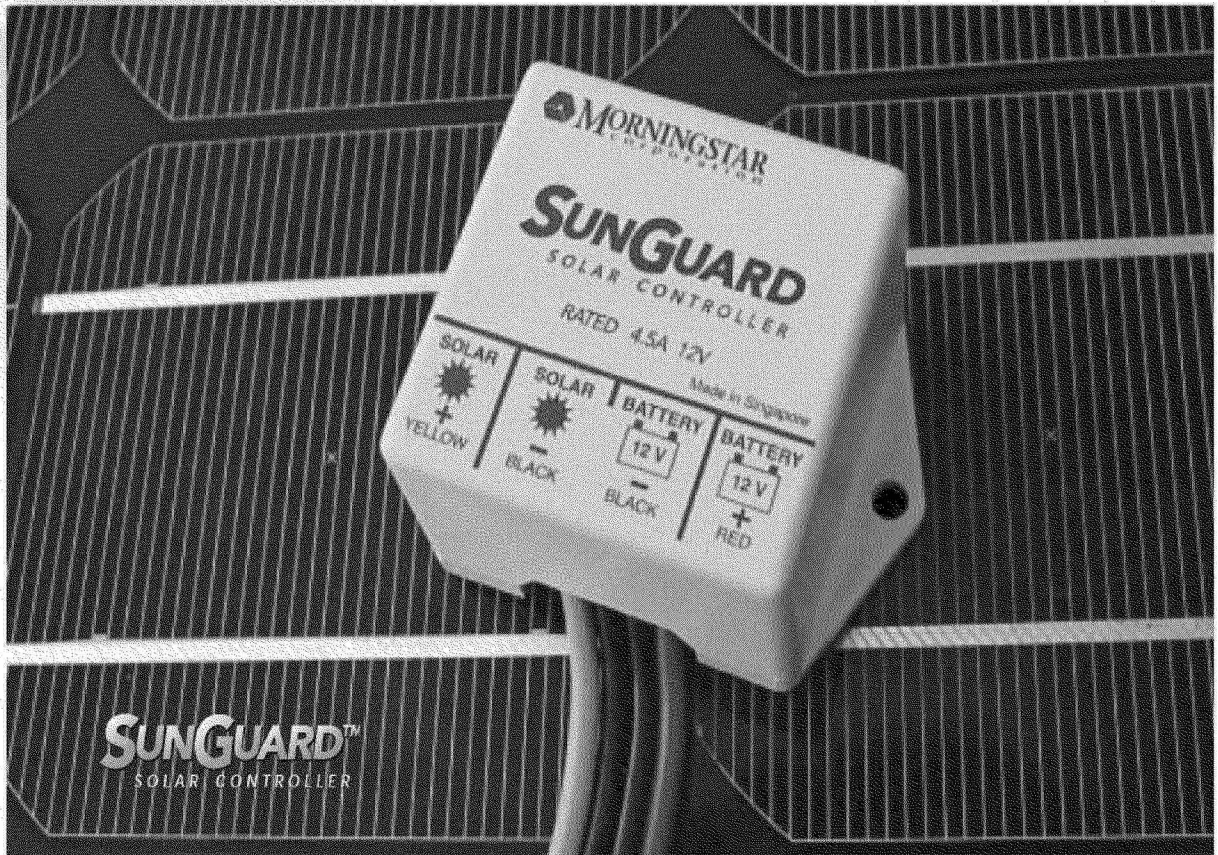5-year limited warranty of materials and worksmanship

Certifications

IEC61215, TUV certification

UL 1703 certification

ETL Class I ,Division 2,Groups C and D certification
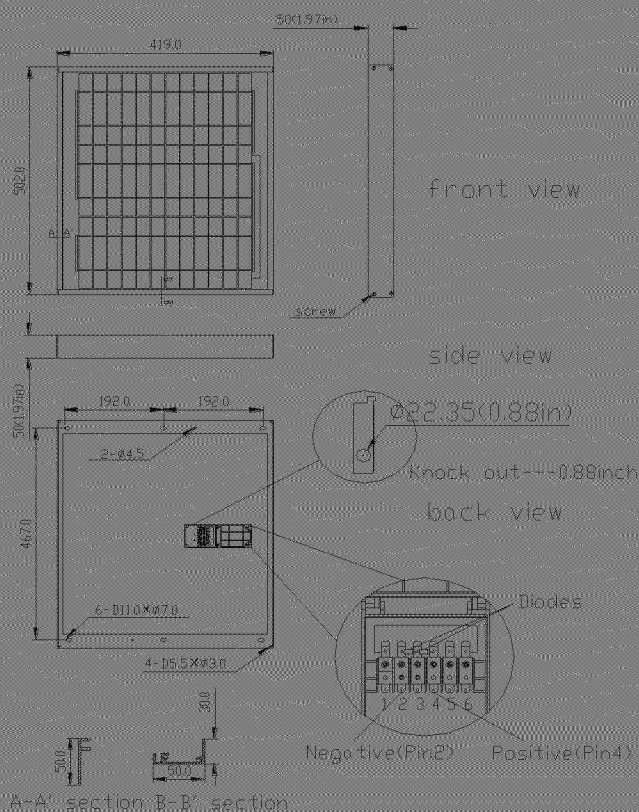
ATTACHMENT 7

SOLAR
CONTROLLER
DATA **S**HEET

MORNINGSTAR
corporation

Morningstar's *SunGuard* is the most advanced small, economical solar charge controller on the market today.

SunGuard's technology provides:

- Exceptional Reliability
- PWM Battery Charging
- Consistent High Quality
- Low Cost

The SunGuard is able to match the quality and performance of the world-leading SunSaver controllers because:
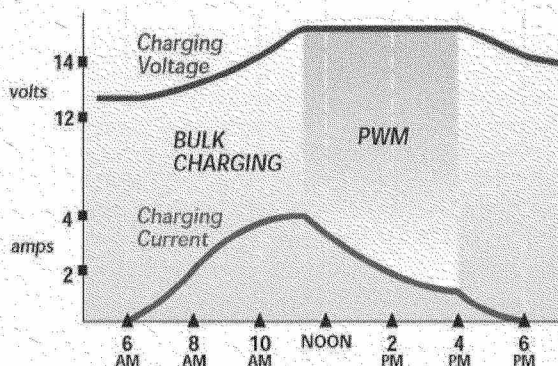
- SunGuards are made on the same high speed, automated production lines
- SunGuards use the same charging circuit
- SunGuards use the same high quality components

Features:

- ISO 9002 quality programs
- Series design (not shunt)
- 100% solid state
- True 0 to 100% PWM duty cycle
- Setpoint accuracy to 60 mV
- Temperature compensation
- Rated for 25% overloads
- No need to derate
- Lightning protected with 1500 W transorbs
- Self-consumption is 6 mA
- Fully encapsulated in epoxy potting
- ABS plastic, impact-resistant case
- Outdoor rated, Hypalon connecting wires

SUNGUARD™ TECHNICAL SPECIFICATIONS

Advanced PWM Battery Charging

Charging Voltage

BULK CHARGING — *PWM*

Charging Current

volts: 14, 12
amps: 4, 2

6 AM | 8 AM | 10 AM | NOON | 2 PM | 4 PM | 6 PM

MORNINGSTAR corporation

SUNGUARD
SOLAR CONTROLLER
RATED 4.5A 12V
MADE IN TAIWAN

| SOLAR | SOLAR | BATTERY 12V | BATTERY 12V |
| YELLOW | BLACK | BLACK | RED |

2.0 (51)
2.5 (64)
2.0 (51)
1.5 (38)

inches (mm)

PV+
PV–
B+
B–
PV | DAY NIGHT | PWM | LOGIC | BATTERY

Advantages

SunGuard's PWM charging compared to On-Off solar regulators:

- Typically 30% more solar energy into the battery per day
- Average battery State-of-Charge is 90 - 95% compared to 55 - 60% for On-Off regulators
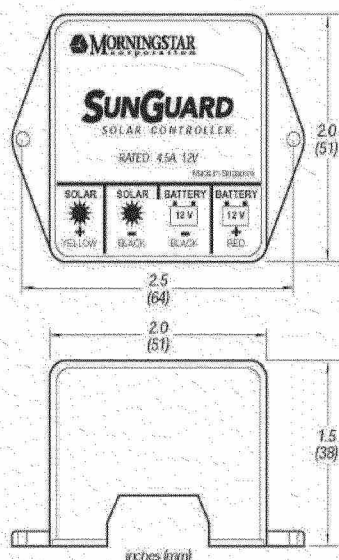
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## Mechanical Specifications

Wire size #16 AWG

ABS plastic case

Epoxy encapsulated

Weight is 3 oz (0.09 kg)

Electrical Specifications

Rated Solar Input	4.5	Amps
Max. Input (5 min.)	5.5	Amps
System Voltage	12	Volts
Max. Solar Voltage	30	Volts
Regulation Voltage	14.1	Volts
Accuracy	60	mV
Self-consumption	6	mA
Temp. Compensation	-28	mV/°C
Reverse Current Leakage	<10	µA
Operating Temperature	– 40 to +85°C	
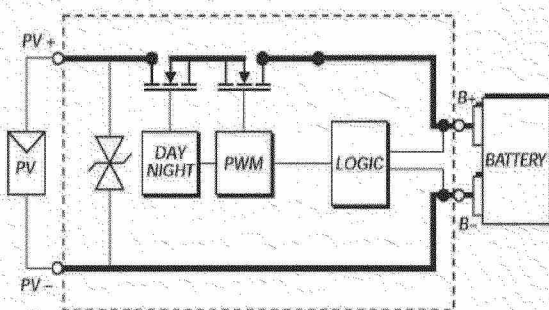
WARRANTY: *Five year warranty period. Contact Morningstar or your authorized distributor for complete terms.*
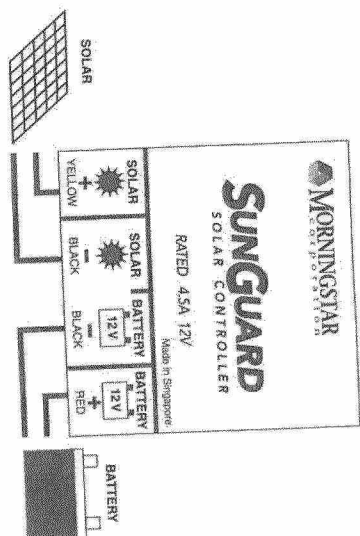
AUTHORIZED MORNINGSTAR DISTRIBUTOR:

MORNINGSTAR corporation

Available From

COLORADO SOLAR
38150 River Frontage Rd.
New Castle CO.
970-984-3750
solarpanelstore.com

CE

SunGuard SOLAR CONTROLLER

MORNINGSTAR CORPORATION

SunGuard
RATED 4.5A 12V
Made in Singapore

SOLAR YELLOW | SOLAR BLACK | BATTERY BLACK | BATTERY RED
12V | 12V
BATTERY

SPECIFICATION SUMMARY

|				
System Volts	12 V	Max. Solar Short Circuit	5.5 A
PWM Setpoint	14.1 V	Rating	
Max. Solar Volts	30 V	PWM Temp	
Accuracy	±60 mV	Compensation	-28 mV/°C
Rated Solar Input	4.5 A	Reverse Current Leakage	<10 µA
Min. Operating Volts	6 V	Ambient Temperature	
Max. Input (5 min.)	5.5 A	Range	-40 to +60°C
Self-consumption	6 mA	Relative Humidity	100%

INSTALLATION

1. SunGuard can be mounted in any position. It is best to mount to a vertical surface and allow space for air flow through the controller.
2. First connect the Battery BLACK wire (negative) to the battery. Use either black wire since they are connected together inside the controller.
3. Connect the RED Battery positive wire to the battery.
4. Connect the Solar array using the other BLACK wire and the YELLOW Solar positive wire. Be very careful not to short circuit the solar array, or the controller will be damaged.
5. SunGuard prevents reverse current leakage at night, so a blocking diode is not required in the system.
6. A negative earth ground at the battery is recommended for most effective lightning protection.
7. SunGuard can be mounted outdoors. Do not expose to ambient temperatures above 60°C. Make sure that water will drain from inside the case.

2

SunGuard™

SOLAR BATTERY CHARGE CONTROLLER
RÉGULATEUR SOLAIRE DE CHARGE DE BATTERIE
SOLARLADUNGSREGLER
CONTROLADOR DE CARGA DE BATERÍA SOLAR
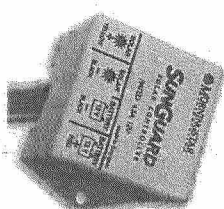
For a more detailed manual, please visit our website.
Pour plus de détails sur le manuel, s'il vous plaît visitez notre site Web
Für eine detaillierte Anleitung, besuchen Sie bitte unsere Website
Para un análisis más detallado manual, por favor, visite nuestro sitio web

MORNINGSTAR corporation
e-mail: info@morningstarcorp.com
website: www.morningstarcorp.com

ATTACHMENT 8

SITE USE
PROCEDURES

ATTACHMENT 8
Site Use Procedures

A list of procedures for a typical data collection site visit:

1. Enter the Sonoita Creek Ranch Property off of State Road 82. The most notable landmark at this turn is a billboard sign advertising for Ranchers Well Drilling Services. If locked, the combination lock code for the front gate is 2000. Remember to leave all gates in the condition that you found them in.

2. Proceed past the ranch house to the location of the flow monitoring system as identified in *Figure 3* of the preceding installation report.

3. Open the barbed wire rancher's gate and NEMA enclosure door. You will need gloves and a flat head screw driver for these tasks.

4. Plug a laptop, which already has the FSDATA Desktop Software (FL900) downloaded, into the loose USB cord attached to the data logger. This software is available for free from Hach's website at http://www.hachflow.com/flow-data-software/software_download.cfm.

5. Open the FSDATA Desktop Software. Once the FL900 data logger is recognized, select the "Download…" button in the upper right corner. Select that excel compatible output format and save the data to the laptops hard drive.

6. Check that none of the electrical connections to the solar panel, battery, or terminal block have come lose or been damaged. For reference of the original condition of these wires see the photopages provided as *Attachment 9* of the preceding installation report. If any issues are suspected use a volt meter to check the voltage and amperage reading on all of the connections on the terminal block.

7. Examine the channel upstream and downstream of the flume as well as the flume itself for any debris that may be blocking the flow path. If any is found, remove the debris to ensure smooth flow through the flume.

ATTACHMENT 9

**REPRESENTATIVE
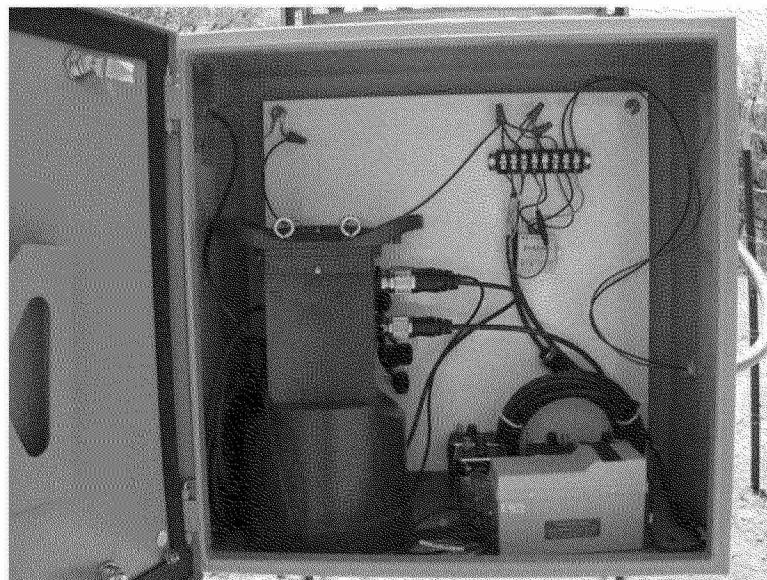PHOTOGRAPHS**

Photo 1. Pre-existing Channel Conditions
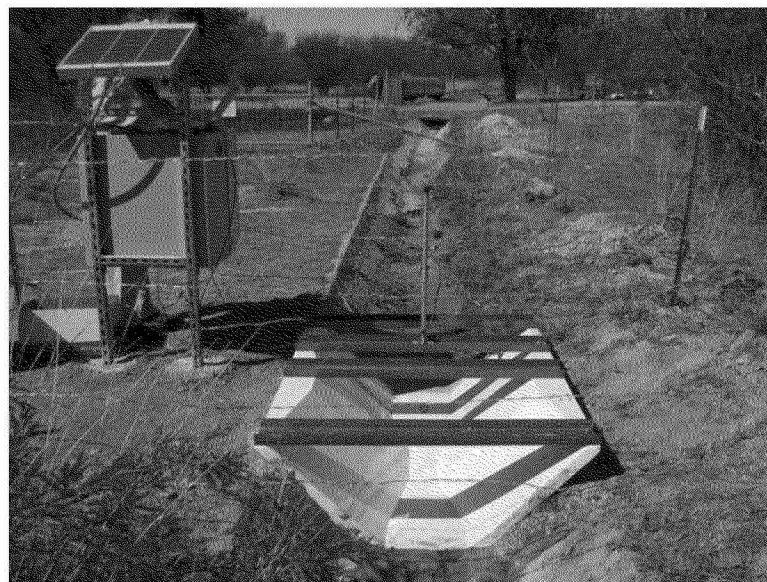
Photo 2. Trapezoidal Flume Installed in Channel

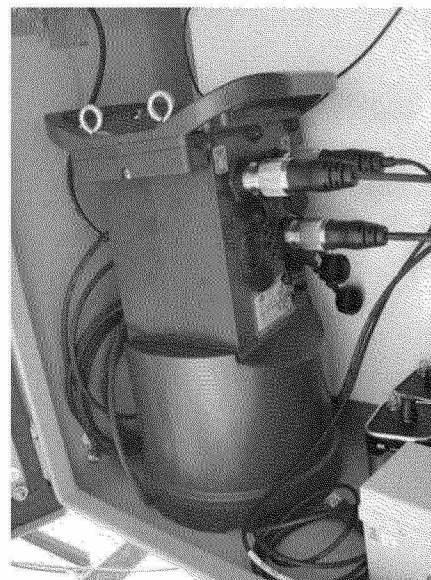**Photo 3.** Flow Monitoring System Set-up
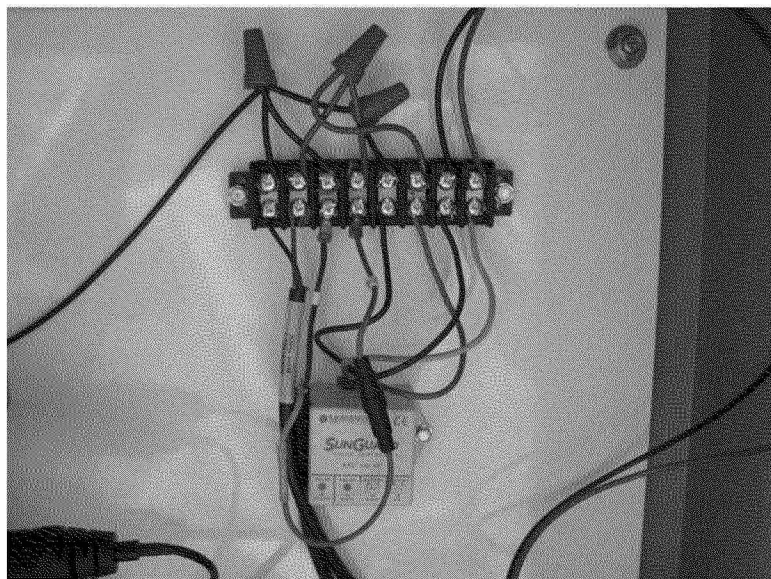

Photo 4. NEMA Enclosure Contents

WestLand Resources, Inc.
Engineering and Environmental Consultants

Representative Photographs
Attachment 9

PHOTOPAGE 1

Photo 5. Batteries

Photo 6. FL900 Data Logger

Photo 7. Terminal Block

Photo 8. Flume Grouted Transition

WestLand Resources, Inc.
Engineering and Environmental Consultants

Representative Photographs
Attachment 9

PHOTOPAGE 2